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June 21, 1934

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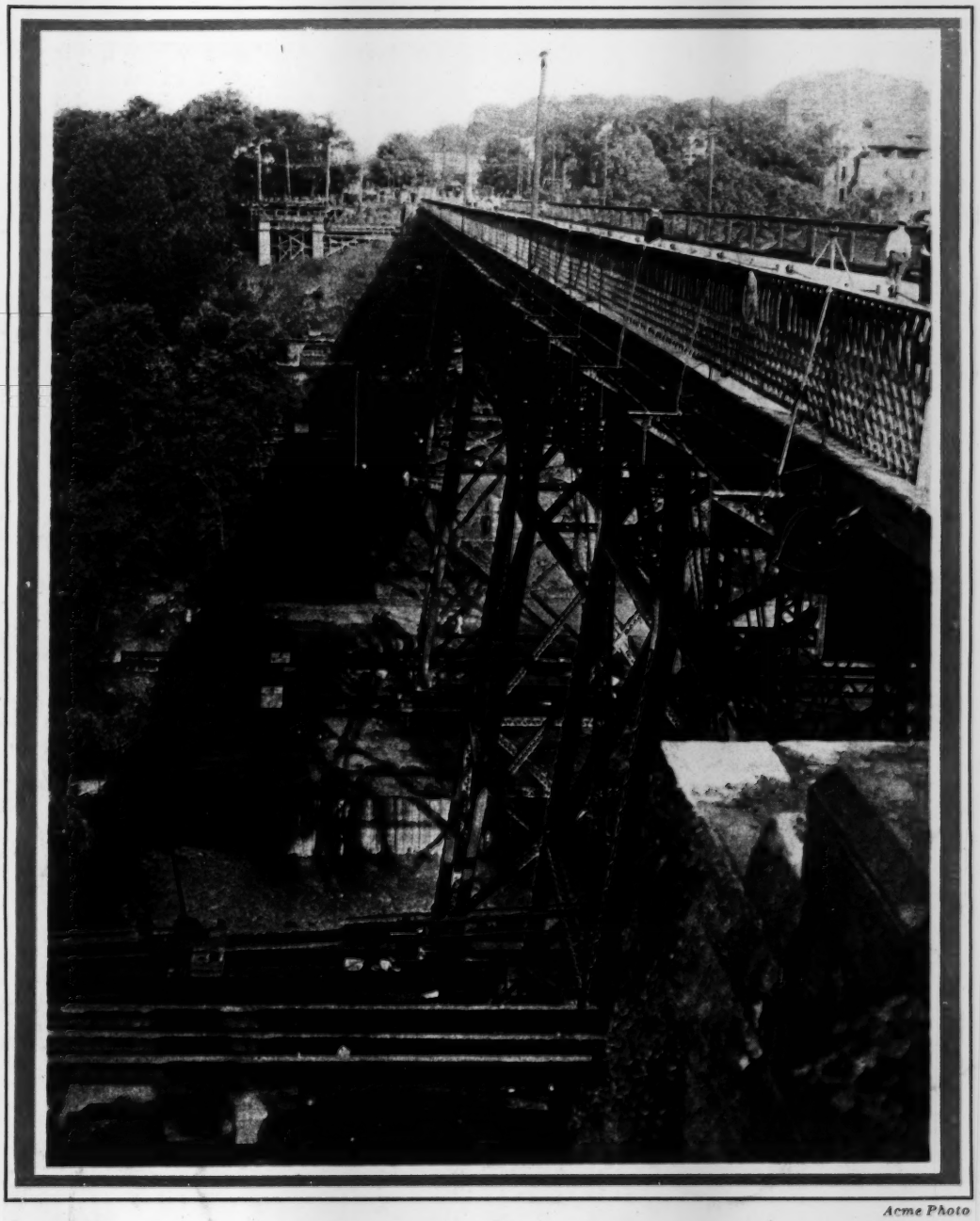


Acme Photo

From right to left, on June 7, the old Calvert Street Viaduct in Washington, D. C., 125 ft. high and 750 ft. long, was moved 80 ft. in 8 hours to new foundations where it will serve as a detour while a new bridge is being built.

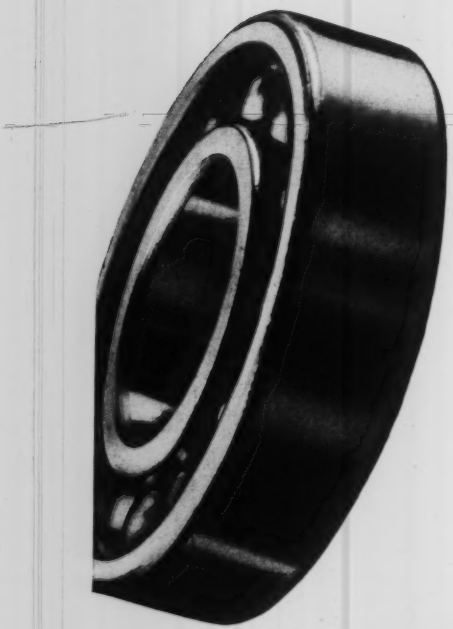
New Shovel Has Gluttonous Appetite

P&H ENGINEERS went the limit to obtain speed, efficiency, smooth and economical operation in this Model 1400 Ward Leonard electric shovel. Since New Departure Ball Bearings have a reputation for these same qualities, their choice was a logical one.

Nine New Departures are used in the swing-motor gear reduction, intermediate hoist shaft and clutch.

It's good judgment to look for New Departures when buying new equipment. Nothing Rolls Like a Ball.

The New Departure Mfg. Company, Bristol, Connecticut. Branches at Detroit, Chicago, San Francisco, and London, Eng.



NEW DEPARTURE

BALL BEARINGS

ENGINEERING NEWS-RECORD

Editorial Staff
V. T. Boughton
W. G. Bowman
C. S. Hill

Chicago
W. W. De Berard

McGraw-Hill Publishing Co., Inc. Editorial and Publishing Offices: 330 West 42d St., New York

F. E. SCHMITT, *Editor* — WILLARD CHEVALIER, *Vice-President*

Editorial Staff
F. W. Herring
H. W. Richardson
J. I. Ballard

San Francisco
N. A. Bowers

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In the News:

CONGRESS substituted a labor-disputes resolution for the much-discussed Wagner Bill, passed it and sent it to the President for signing. Limited to a life of one year, the resolution authorizes the President to supervise labor elections to the end that Section 7A of NIRA may be obeyed. The right to strike is specifically provided for.

THE THREATENED STEEL STRIKE was averted by President William Green of the A. F. of L. The Labor proposal is for a board of three to be appointed by President Roosevelt, to handle all disputes. Details and differences remain to be worked out.

BUILDING LABOR moved last week to clear up the vexatious jurisdictional disputes that have been delaying construction work. Carpenters', bricklayers' and electricians' unions reaffiliated with the other unions in the A. F. of L. building trades department, with whom they have been at odds for some years.

TVA HAS OFFERED Electric Bond & Share $6,500,000 for all the electric properties of the Tennessee Public Service Co., in Knoxville, except the street-car system. The plan is to resell the Knoxville distribution system to the city and integrate the generating plant with the TVA system. The utility company contends that the offer is not adequate to cover its obligations to bond holders and preferred-stock holders.

PRESIDENT ROOSEVELT plans to visit Bonneville, Grand Coulee and Fort Peck late in July on his return from Hawaii and the West Coast.

PROGRESS in both railway operation and city smoke abatement is provided for in a new $2,000,000 PWA loan to the Illinois Central Railroad Co. A streamlined high-speed train will be purchased and, in addition, eleven diesel locomotives will replace steam locomotives in the Chicago lake-front district.

MORE THAN a quarter-billion dollars' worth of materials for public-works projects were ordered between October and April, according to PWA. Equipment purchases are not included in the total. Iron and steel account for $125,000,000, highway materials for $60,000,000, lumber for $15,000,000, and other building materials for $17,000,000.

THE HOUSING BILL was finally passed by Congress in a form that is believed to be acceptable to the Administration. In the meantime the PWA Housing Division (limited-dividend projects) was absorbed by the Public Works Emergency Housing Corp., as another step in the Administration plan to consolidate all federal housing activities in one place.

In This Issue:

WASHINGTON RESIDENTS were treated to a spectacular show two weeks ago, when contractors John W. Cowper and John Eichleay, Jr., chose to move the long, high and old Calvert St. Viaduct to one side and use it as a detour while building a new bridge instead of constructing a temporary trestle, which was the other alternative. In addition to signifying resourcefulness, skill and probably good business sense, the moving job was good publicity for the construction art.

THE NEW DEAL TWINS, NRA and PWA, celebrated their first birthday last week. Accomplishments, fittingly, were emphasized. The most revealing statistical tabulation of PWA progress yet made public was given out. Charts show large wide-open spaces between expenditures, contracts awarded and allotments, auguring well for continued construction activity.

TWO DECADES of planning and hoping for safety from floods in southeastern Ohio have culminated in the actual start of design and construction preliminaries on the Muskingum River conservation program. Some $22,000,000 of PWA funds are available. Fourteen reservoirs are contemplated as one of the first steps.

A REORIENTATION of civil engineering training, predicated on the new public-works consciousness of the country and the potentialities of a coordinated construction industry, is planned by New York University. The need for such reorientation is presented and analyzed in an article in this issue.

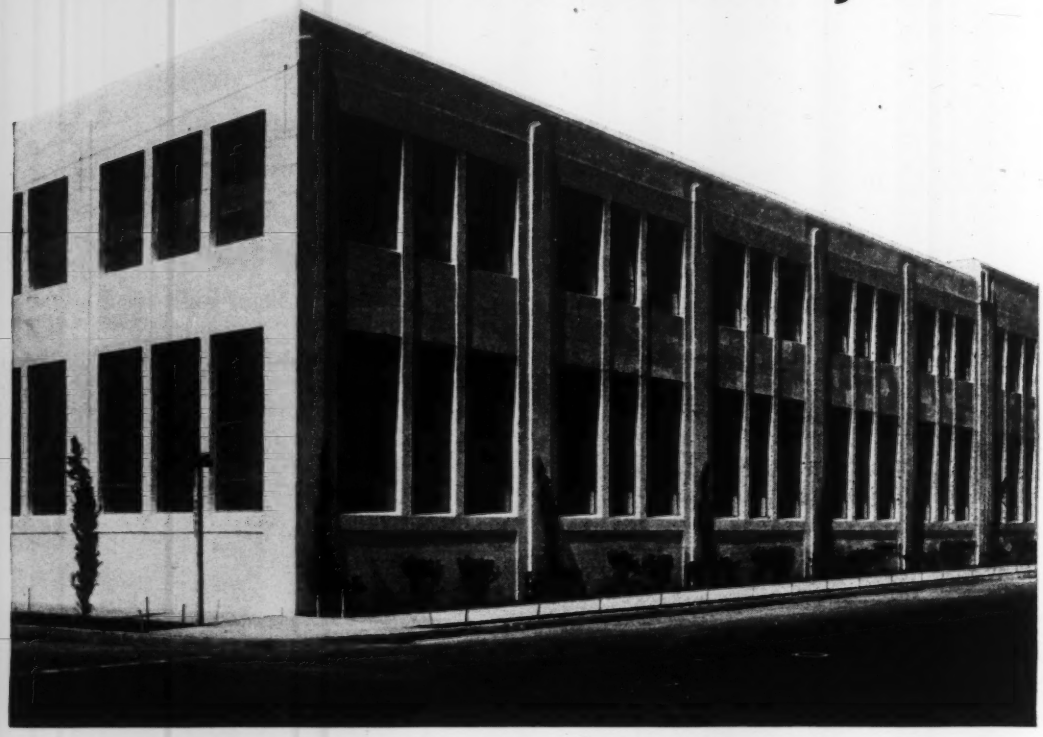
A FORMULA for determining the probable 100-year flood, developed several years ago, is presented for the first time in a simplified form applicable to the whole United States.

THE BOUQUET CANYON DAM just completed by the city of Los Angeles is notable as the successor of the ill-fated St. Francis Dam, which failed so disastrously about six years ago. The new dam is an earthfill structure 185 ft. high, and the reservoir is filled and discharged through a single 3½-mile welded-steel pipe line.

THE LAST OF THE FOUR ARTICLES on stabilized soil-bound road surfaces considers costs of construction and maintenance, based on practices in Michigan.

INDIANA has used a $3,000,000 PWA loan and grant to widen shoulders on 1,000 miles of its primary road system. A peak employment of 35,000 was attained, and the work represents a permanent improvement of great value.

Another neat stucco job



with stucco of Atlas White

There's one thing about white portland cement stucco—you can get just the right color to fit the structural and architectural design and to bring out the full beauty of the texture used. On this Los Angeles office and factory building, architect John M. Cooper wanted a clean, light, smooth exterior finish—neat and business-like. Using *Eclipse Stucco*, a prepared stucco (which is preferable), plastering contractor Howard A. Booher did the job pictured above.

We haven't seen any glowing testimonials, but from the looks of it, it's our bet that this job was most satisfactory. We're proud to say that it's another good stucco job made with Atlas White. If you would like detailed information on this kind of good stucco, we'll be glad to send it promptly. Write Universal Atlas Cement Co., *Subsidiary of United States Steel Corporation*, 208 South La Salle Street, Chicago.

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ATLAS WHITE PORTLAND CEMENT

PLAIN OR WATERPROOFED

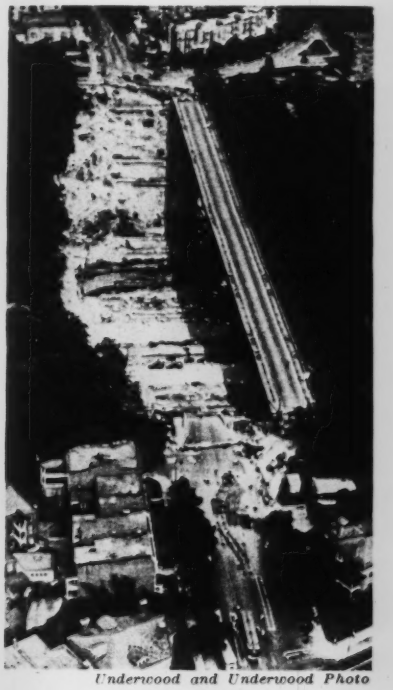
ENGINEERING NEWS-RECORD

New York

June 21, 1934

High Steel Trestle Moved Intact to New Location

Old Calvert St. Bridge across Rock Creek in Washington is shifted 80 ft. to make way for new multiple-arch concrete structure—Old bridge to serve as detour during construction



Underwood and Underwood Photo

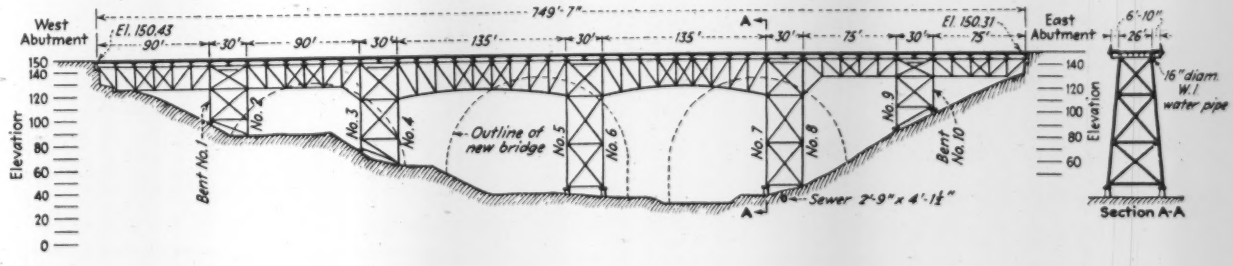
FIG. 1—OLD CALVERT ST. BRIDGE, Washington, in its new location to serve as a detour, after being moved intact 80 ft. from its resting place of 43 years.

FIVE HORSES and two men, each turning about an old-fashioned house-moving capstan, slowly shifted the long, towering Calvert Street steel trestle across Rock Creek in Washington, D. C., from its resting place of 43 years to a temporary location 80 ft. to the south. A multiple-arch concrete structure will replace the trestle, with the old bridge serving as a traffic detour during the construction period. At midnight, June 6, traffic was barred from the old trestle; at 7:30 a.m. the following day actual moving started; by 3:30 p.m. the same day the bridge was in its new location. The structure was rolled intact from the bottom of the tower legs to deck over a system of tracks on cribbing.

The bridge was almost ready for moving on May 1, when preparations were halted by a strike of carpenters. After waiting nearly six weeks for a settlement of the labor trouble, the district authorities arranged with the contractor to move the structure without completion of the highway approaches, that work being practically the only preparations not finished when the carpenters went out. The approach work was far enough advanced to permit operation of street cars over the bridge in its new location. Highway traffic is being detoured pending settlement of the strike and completion of the approaches.

The old bridge, weighing 1,226 tons, is a deck-truss structure 750 ft. long, with six spans varying in length from 75 to 135 ft., carried on five steel towers and two abutments, as shown in Fig. 2. Each tower is built up of four laced steel columns with lattice bracing, which replaced the original tierod bracing several years ago. The maximum height of tower, at the center of the gorge, is 125 ft. from top of pedestal to deck. The trusses, spaced 25 ft. apart, carry steel floor beams supporting a 26-ft. wooden roadway deck with two street-car lines; there are also two cantilevered sidewalks. A 16-in. water main, electric power lines and a telephone conduit carrying 42,000 wires are supported under the deck. During moving operations the water line was cut off permanently, the telephone cables

FIG. 2—THE OLD BRIDGE consists of six deck-truss spans carried on high steel towers.



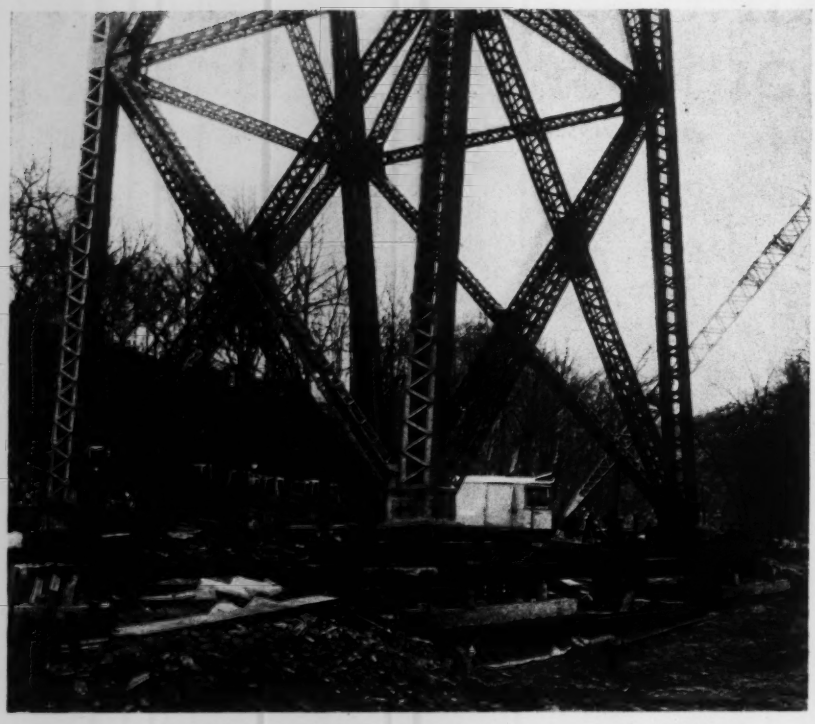


FIG. 3—THE ROLLING SUPPORTS for the highest tower in the old bridge, bents 5 and 6, being set in position. On bent 6 timber cradles supplemented the standard steel grillages used elsewhere.

took up previously spliced loops at each end, and the power circuits were transferred to temporary lines strung across the gorge.

Preparations for moving

Foundations for the old bridge in its new location consist of concrete piers under each tower leg, carried either to rock or to firm bearing. In some cases it was necessary to go down 30 ft. below ground level with the temporary piers.

At the north end of the east abutment, where a deep temporary pier was built on a steeply sloping bank, the foundation for the south end of the abutment for the new bridge was built at the same time because of its close proximity.

A timber trestle approach was built at each end of the new location. A considerable amount of trestle was required at the west end to correspond to a fill approach on the original alignment. The approach trestles are built up of framed bents with steel floor beams and a plank deck. Street-car tracks were set into the wood flooring.

Tracks on which the bridge was moved consisted of two sets of railroad rails straddling each tower bent. The rails, placed 20 in. apart parallel to line of moving, were carried on timber cribbing built up from the uneven ground line. On each set of two rails were placed assemblies of 2½-in. steel rollers over which moved a steel carriage, tied to the tower legs. The rollers were spaced and kept parallel by means of slotted steel side plates.

FIG. 5—PICK-UP DETAILS at bent 2 before the load was transferred to the track structure.

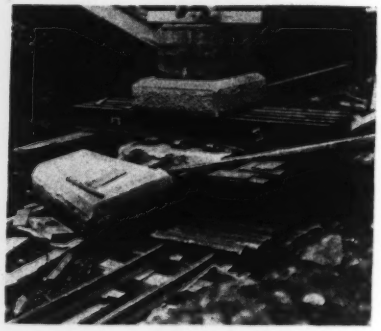
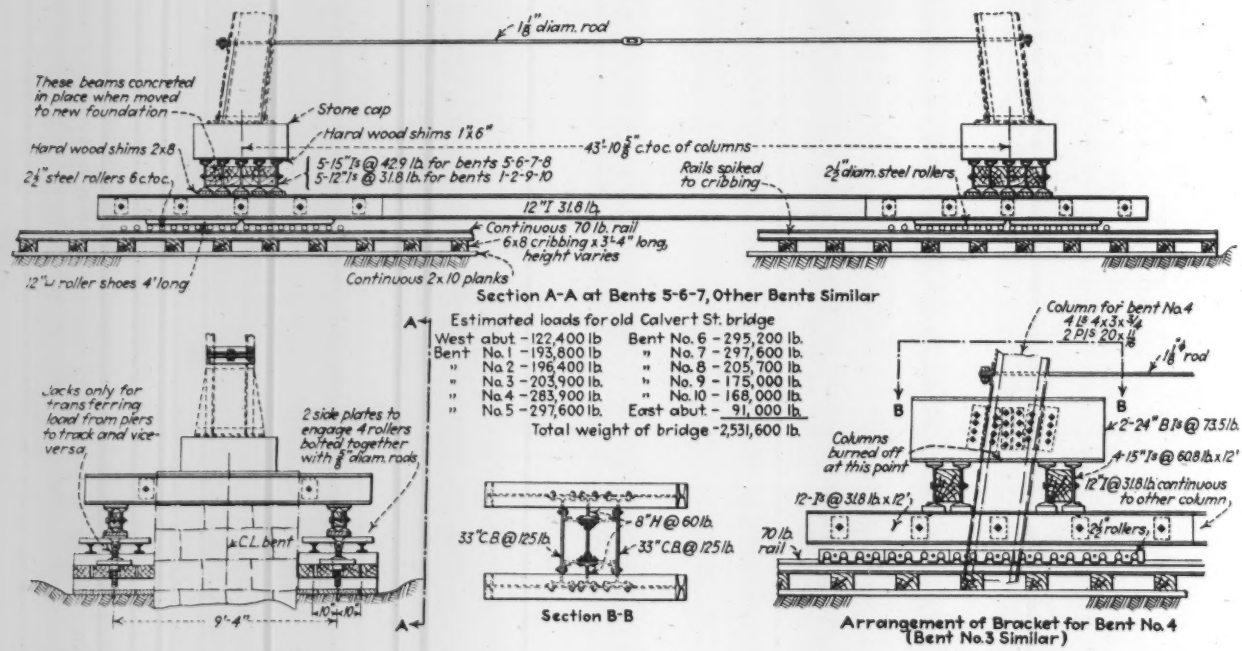
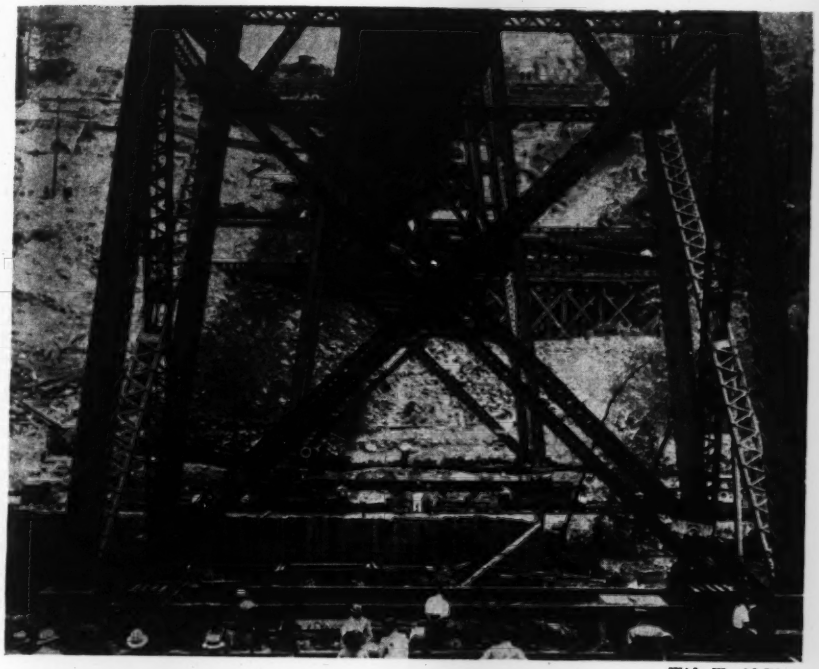


FIG. 4—DETAILS of typical rolling support assemblies. Tower legs on four of the five towers were picked up under the capstones of the original piers; legs of the fifth tower were picked up with a bolted assembly shown in the lower right corner.


1⅛" diam. rod
These beams concreted in place when moved to new foundation
Stone cap
Hard wood shims 2x8
Hard wood shims 1"x6"
43'-10⅝" c.to c. of columns
2½" steel rollers 6 c.to c.
5-15" I's @ 42.9 lb. for bents 5-6-7-8
5-12" I's @ 31.8 lb. for bents 1-2-9-10
Rails spiked to cribbing
2½" diam. steel rollers
12" I 31.8 lb.
Continuous 70 lb. rail
6x8 cribbing x 3'-4" long, height varies
12" ⊔ roller shoes 4' long
Continuous 2x10 planks
Section A-A at Bents 5-6-7, Other Bents Similar
Estimated loads for old Calvert St. bridge
West abut - 122,400 lb
Bent No. 1 - 193,800 lb
" No. 2 - 196,400 lb
" No. 3 - 203,900 lb
" No. 4 - 283,900 lb
" No. 5 - 297,600 lb
Bent No. 6 - 295,200 lb.
" No. 7 - 297,600 lb.
" No. 8 - 205,700 lb.
" No. 9 - 175,000 lb.
" No. 10 - 168,000 lb.
East abut. - 91,000 lb.
Total weight of bridge - 2,531,600 lb.
Jacks only for transferring load from piers to track and vice-versa
2 side plates to engage 4 rollers bolted together with ⅞" diam. rods
℄ C.L. bent
9'-4"
8" H @ 60 lb.
33" C.B. @ 125 lb.
33" C.B. @ 125 lb.
Section B-B
Column for bent No. 4
4 ℓs 4x3x¾
2 Pls 20x1⅛
1⅛" rod
2-24" B I's @ 73.5 lb.
Columns burned off at this point
4-15" I's @ 60.8 lb. x 12'
12" I @ 31.8 lb. continuous to other column
12-I's @ 31.8 lb. x 12'
2½" rollers
70 lb. rail
Arrangement of Bracket for Bent No. 4
(Bent No. 3 Similar)



Wide World Photo

FIG. 6—VIEW OF THE BRIDGE during moving operations, showing high cribbing and trestles required to carry tracks under bents 9 and 10.

In general, the plan of cutting loose the tower legs from the original stone piers was to work a set of five 12-in. or 15-in. I-beam needles, placed parallel to the center line of the bridge, under the capstone of each pier, one at a time. One course of stone, the second from the top, was removed from each pier in this process. Tie-bolts and hardwood spreaders were used to tie these beams into a unit of grillage under each tower leg. Wedges above and below the beams took up on the stone courses left in place.

Next, a pair of 12-in. beams, 12 ft. long, was placed on the rollers, parallel with and directly over the tracks. The bottoms of these beams carried two sets of steel-coverel shoes bearing directly on the rollers. One of the two longitudinal beams of each set was spliced to a beam extending to the corresponding beam of the other bent leg, tying the whole temporary support of one bent into a rigid carriage. Small screw jacks and wedges were used to transfer the load from the piers to the track carriage.

Most of the new piers were built to an elevation slightly below that of the bottom of the grillage beams. The grillages were left in place and encased in concrete after the move had been completed. But on bents No. 3 and No. 4 the lower ends of the columns had been encased with concrete as protection against a subsequently placed fill, so the columns were cut off above the concrete encasement. The same general plan was used in building up the carriages, except that bolted connections to the tower legs, as shown in Figs. 4 and 8, replaced the usual capstones.

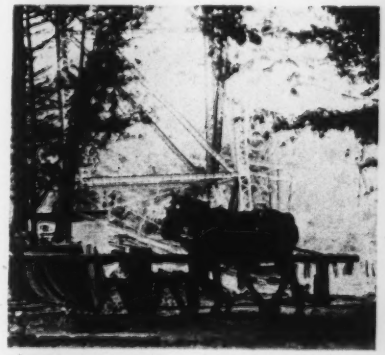


FIG. 7—EACH of the five towers were pulled with horse-operated capstans. Manpower capstans handled the abutment ends.

FIG. 8—COLUMNS in bents 3 and 4 were cut loose from old piers and picked up by bolted assemblies. Track structure not yet in place.

Moving with capstans

Seven capstans, anchored to deadmen on the bottom and along the sides of the gorge, provided the pulling power, a separate capstan handling each of the five towers and two abutment ends. Each of the five tower capstans were operated by a horse, but those for the abutment ends were hand-operated. The capstans were rigged with ten-part line blocks-and-falls, the lines for the towers being attached to a cross-beam fastened to the front end of the two bent carriages on each tower.

With the multiple-line rigging and the slow, but steady, turning of the capstans, the movement of the bridge was easily controlled. Screw jacks set between the back ends of the carriage and the track structure aided in getting the move started. Whistle signals governed the move, with observers stationed at each bent. Original plans called for starting and moving the structure the first 4 in. with the screw jacks, but the bridge rolled so easily that the starting jacks were extended full length, 8½ in., before the cables took the pulling load. For the next 7 ft. the moving was in increments of 6 in., with careful checks being made between each pull as to alignment. For the remainder of the move the length of pull was increased to 12 in. During the move careful checks were made at several stations for maintenance of alignment and grade. At no point did the bridge get more than 1½ in. out of level, indicating the substantial construction of the cribbing. Alignment was maintained within 2 in. at all points. No undue stresses in any part of the structure were noticed during moving operations.

At the end of the move, jacks transferred the load from the tracks to the piers, and the grillages were encased with high-early-strength concrete.

Moving of the old bridge and construction of the new structure is being carried on by the Board of Commissioners of the District of Columbia, under the direction of Maj. John C. Gotwals, engineer commissioner, Capt. H. W. Whitehurst, director of highways, Clifford R. Whyte, engineer of bridges, and A. Green, resident engineeer. The John W. Cowper Co., of Buffalo and Washington, holds the contract for the new bridge, which included providing a detour structure, either by building a timber trestle or by moving of the old bridge, the latter being preferred by the contractor. S. K. Pierce, vice-president, George Herman, general superintendent, Charles B. Vannier, superintendent, and F. H. Martell, engineer and assistant superintendent, are in charge for the contractor. Modjeski, Masters & Case, Philadelphia, are consulting engineers. The John Eichleay Jr. Co., Pittsburgh, was subcontractor on the moving of the old bridge.

EDITOR'S NOTE—Just as these pages were going to press word was received that a concrete deck is being substituted for the timber roadway on the approaches, permitting the bridge to be opened to highway traffic this week.

Progress Made by the PWA in the First Year of Its Life

One-third of the three billion dollar public-works fund distributed and the whole fund allocated—Rapid increase in work on non-federal projects since January of this year

By Irvin Foos
Washington Office, Engineering News-Record

THE Public Works Administration celebrated its first anniversary on June 16. A year ago on that date the National Industrial Recovery Act went into effect, and under the authority vested in him by Title II of the act the President set up the Public Works Administration headed by a special board of public works consisting of the Secretary of the Interior as chairman, the Secretary of War, the Attorney-General, the Secretary of Agiculture, the Secretary of Commerce, the Secretary of Labor, the Director of the Budget, the Assistant Secretary of the Treasury and Col. George R. Spalding. The same executive order that appointed this board appointed Donald H. Sawyer to the temporary office of federal emergency administrator of public works, but on July 8 this temporary appointment was terminated and Harold L. Ickes, Secretary of the Interior, was appointed federal emergency administrator for public works. On July 24 Henry M. Waite was appointed deputy administrator and was designated a member of the special board for public works to succeed Col. George R. Spalding. Since that time the composition of the special board has not been changed.

The principal function of the special board for public works was to pass upon all recommendations for allotments to applicants for loans or grants from the public-works fund of $3,300,000,000 set up under the National Industrial Recovery Act. Actual allotments were to be made by the President upon the recommendation of the board, and broad powers were vested in the board as to the character of the projects to be financed from the public-works fund. The only allotments specifically stipulated by Congress in drafting the act were $400,000,000 for highway work, $238,000,000 for the construction of naval vessels, $100,000,000 for the purposes of the Agricultural Adjustment Act, and $25,000,000 for subsistence homesteads. The rest of the money could be used for all types of public works, either federal, state or municipal, and even for loans to finance privately owned projects for public service. Financing of state and municipal work was to be either through loans or combined loans and grants, the grants to be not in excess of 30 per cent of the cost of labor and materials.

In one year the public-works program has been projected into every state and practically every county of the country, with money made available for waterworks, sewerage, schools, roads, streets, parks, libraries, heating and lighting plants, hospitals, asylums, bridges and tunnels. Grants and loans for non-federal projects include $156,000,000 for sewers and sewage disposal, $75,000,000 for waterworks, $94,000,000 for school and college buildings, $50,000,000 for streets and highways, in addition to the $400,000,000 specifically allocated to the states for highway construction in the act itself, also $10,000,000 for municipal electric-light plants. In all, the federal and non-federal projects number more than 15,000 and range in amount from a few hundred dollars to $42,000,000. As a result, the huge appropriation of $3,300,000,000 has dwindled to $2,221,273,855. But of the $1,078,726,115 dis-

FIG. 1—NON-FEDERAL project allotments plotted cumulatively, also cumulative figures for contracts awarded and expenditures for such projects.

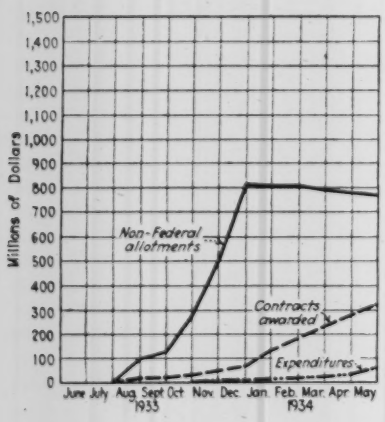


FIG. 2—FEDERAL project allotments plotted cumulatively, also cumulative figures for work let by contract or started by force account and total expenditures to June 1, 1934.

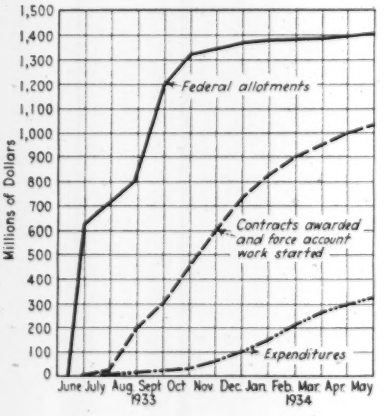
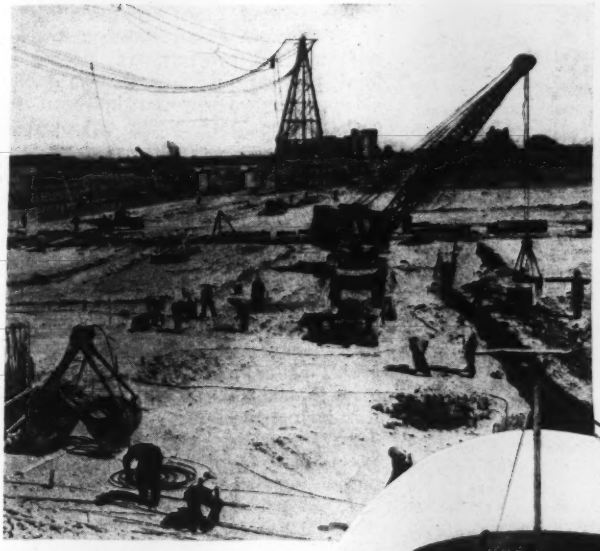


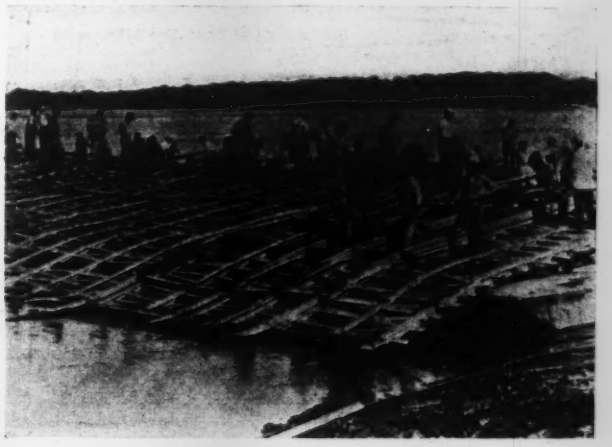
TABLE I—PROGRESS ON FEDERAL PROJECTS

Agency	Allotments	Contracts Awarded	(Est. Cost) Day-Labor Work Started	Total Awards and Day Labor	Per Cent of Allotments	Cost of Work Now Being Advertised	No. of Men at Work	
							Contract	Day Labor
Forest Service	$40,967,745	$266,797	$24,949,418	$25,216,215	61.3	$43,331	153	13,821
Public Roads	405,015,000	346,640,000	24,920,000	371,560,000	91.9	27,922,000	161,615	15,457
Coast and Geodetic Survey	6,503,120	227,000	3,272,982	3,499,982	53.8	233,000	.....	1,815
Lighthouses	5,620,334	1,969,463	530,381	2,499,844	44.4	775,212	781	167
Geological Survey	4,497,164	197,552	3,443,646	3,641,198	81.0	160,154	22	1,425
Indian Affairs	19,034,550	374,869	12,429,250	12,804,119	67.3	62,660	120	7,821
Nat'l. Park Service	32,097,350	9,778,225	5,601,821	15,380,046	47.8	1,930,044	3,505	1,706
Reclamation Bureau	103,535,000	12,632,438	1,009,110	13,641,548	13.1	56,451,107	6,480	1,284
Soil Erosion Service	10,000,000	.....	2,995,000	2,995,000	29.9	.....	.....	962
Subsistence Homesteads	25,000,000	.....	1,650,000	1,650,000	6.6	.....	.....	1,240
Navy Vessels	238,000,000	128,083,682	94,282,788	222,366,470	93.4	35,563	2,465	6,596
Navy Yards and Docks	27,500,537	18,242,058	6,089,248	24,331,306	88.4	77,265	3,463	2,258
Coast Guard	25,031,872	18,974,753	1,823,800	20,798,553	83.1	392,950	3,237	406
Federal Buildings	67,401,653	16,702,072	.....	16,702,072	24.7	2,356,240	2,175	269
Flood Control	69,187,000	22,648,400	18,946,700	41,595,100	60.2	465,000	6,668	4,060
Rivers and Harbors	179,741,208	140,893,000	9,237,000	150,130,000	83.2	10,089,300	21,333	5,741
Army Seacoast Defense	7,000,000	3,911,645	2,577,169	6,488,814	92.5	60,758	965	2,449
Army Housing and Mechanization	71,009,926	47,564,263	9,357,060	56,921,323	80.1	553,169	15,568	3,878
All Other Federal Projects	70,822,697	20,123,761	23,698,172	43,821,933	61.5	6,081,017	4,952	8,007
Total	$1,407,965,156	$789,229,978	$246,813,545	$1,036,043,523	73.6	$107,688,770	233,402	79,362

TYPICAL PWA CONSTRUCTION IN ITS FIRST YEAR

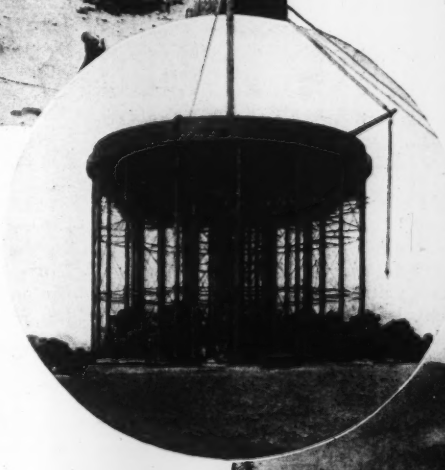


WORK has been resumed on the South Side sewage-disposal plant at Chicago as the result of an allotment of $42,000,000 of PWA funds to the Sanitary District.

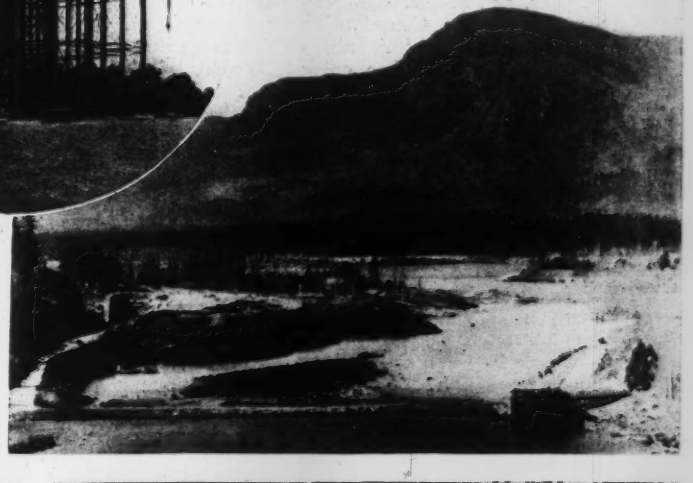


ON THE Mississippi River PWA funds are being used for extensive revetment work. The work here shown is timber-mat construction in the St. Louis District.

THE partly completed cofferdam for the power house and lock at Bonneville Dam on the Columbia River is shown in the side channel which occupies the foreground of the picture below. The main channel is shown in the right center beyond the end of the island that divides the river at the site of the dam.

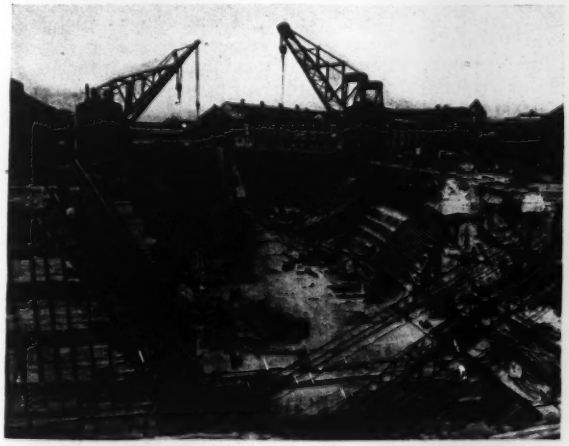


A TANK of 1,500,000-gal. capacity is being erected with PWA funds at Columbia, S. C.



AT GLENDALE, CALIF., the PWA has financed construction of a roof over an existing 15,000,000-gal. reservoir (lower right).

DRYDOCK RECONSTRUCTION at the Navy Yard, Norfolk, Va. (lower left). The Navy Department has received $39,000,000 from the PWA for work other than ship construction.



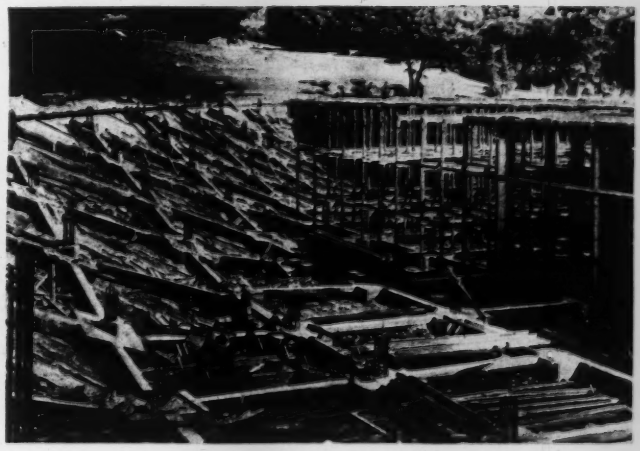


TABLE II—STATUS OF INDUSTRIAL RECOVER APPROPRIATION

Statutory and Executive Allotments

Total Appropriation		$3,300,000,000
Statutory and Executive Allotments		
Farm Credit Administration	$100,000,000	
Tennessee Valley Authority	50,000,000	
Emergency Conservation Work (CCC)	323,362,315	
NRA expenses and reserves	14,465,000	
Civil Works Administration	400,005,000	
Federal Emergency Relief Administration	35,000	
Pub. Works Admin. Expenses and Reserves	56,746,205	
Emergency Housing Corporation	123,671,500	
Agricultural Adjustment Admin	250,000	
National Emergency Council	1,360,000	
Special allotments	1,398,146	
Oil Administration	609,000	
National Planning Board	351,000	
Surplus Relief Corporation	25,000,000	
Electric Home and Farm Authority (TVA)	1,000,000	
Pub. Works Emergency Leasing Corp	1,000	
Relief highways	7,431,000	
Export-Import Bank of Washington (Cuba)	1,250,000	
Air-Conditioning of federal buildings	299,500	
Total deductions		1,107,234,666
Net am't. available for public works		$2,192,765,334
Public-Works Allotments		
Federal	1,408,065,156	
Non-Federal	771,385,613	
Total		2,179,450,769
Balance resulting from adjustments available for re-allotment		$13,314,565

Public-Works Allotments

	Federal	Non-Federal	Tota
Allotments to date	$1,408,065,156	$771,385,613	$2,179,450,769
Number of approved projects	13,200	2,452	15,652
Contracts awarded and force-account work established	1,025,812,710	292,080,707	1,317,893,417
Estimated cost of work now being advertised	108,593,453	66,772,071	175,365,524
No. of men on payrolls, direct on site, exclusive of administrative and supervisory employees	304,845	63,982	368,827

bursed to date, only $425,058,115 has gone to public works proper.

The big program was slow in getting started last year, and $585,570,000 was diverted to the Civilian Conservation Corps and the Civil Works Administration in an effort to produce quick employment. In addition, the Farm Credit Administration and the National Recovery Administration received $68,098,000. There has been some criticism of this dissipation of the fund for purposes other than the construction of public works; but the fund never was earmarked exclusively for that purpose, and the statutory provision for drafts on the fund has been extended by executive allotments over which the Public Works Administration had no control.

As will be seen by the accompanying chart, actual expenditures for non-federal projects at the end of 1933 were negligible, but by the spring of this year the time-consuming complications of execution of bond contracts for such work had been largely overcome, and the construction program, though still lagging several weeks behind the projected curve prepared by the PWA, is now moving forward swiftly.

Of the total allotment of $2,179,450,000 for federal and non-federal projects, contracts have been let or force-account work has started on projects totaling $1,317,893,000, or 60 per cent; and 8 per cent more, $175,365,000, is being advertised.

The federal and non-federal programs in their several stages are shown in Tables I and III, and actual disbursements in Table IV. The disbursement of $162,638,115 on non-federal projects represents the amount that has been deposited by the PWA to the credit of applicants at Federal Reserve banks. Actual withdrawals against these deposits are estimated at $64,000,000.

About $600,000,000 of the $770,000,000 allotted to non-federal projects is represented by secured 4 per cent loans. Combined loans and grants of $450,000,000 have been made to states, municipalities and other public bodies on more than 1,200 projects, the grants representing about $150,000,000. Loans unaccompanied by grants amount to $275,000,000 and include $199,000,000 to the railroad companies for new construction and for the repair or replacement of equipment, $37,500,000 to the Port of New York Authority for the Midtown Hudson tunnel, and smaller sums to limited-dividend housing corporations, toll bridge companies and a few other private companies.

The federal grant, representing 30 per cent of the cost of labor and material on 1,105 projects, was sought by local government agencies who were able to finance the remainder of the cost of the project through private channels. Such grants total about $45,000,000. In recent months nearly 200 applicants to whom the PWA allotted combined loans and grants have asked for grants only and are financing the remainder through the sale of their bonds in the open market. This has released from $25,000,000 to $30,000,000 for reallotment to other projects.

No longer inflated by the CWA program, which gave temporary employment to 4,000,000 people last winter and this spring, the PWA payroll numbered 368,827 directly employed on projects, exclusive of administrative and supervisory employees, at the time of the last report. The PWA believes that the total has reached 400,000 since that report was prepared. By including the Civilian Conservation Corps and other agencies supported from the public-works fund, the PWA employs about 738,000. Back-of-the-line employment with a cumulative total of 600,000 man-hours has been or will be furnished on equipment and material purchases totaling $250,000,000 at the end of April, as reported to the Department of Labor. The tapering off of railroad orders for steel and equipment was offset in May by the expansion in the construction of public works, and the total was expected to pass $300,000,000.

Research work

Apart from its job of pushing the public-works construction program, the PWA is supporting extensive research. The National Planning Board is cooperating with the states in setting up long-range programs. The Mississippi Valley Committee, with the cooperation of the Corps of Engineers and other agencies, has submitted to President Roosevelt a document outlining a national policy in water use, including flood control, power, irrigation, navigation and soil erosion as a basis for a continuing program to provide employment for the permanent surplus of labor. The

TABLE III—PROGRESS OF NON-FEDERAL PROJECTS

Status	Number of Non-Federal Projects	Per Cent of Total Number	Allotments	Per Cent of Total Allotment	Amount of Contracts and Force Accounts	Estimated Total Cost	Per Cent of Total Cost	Estimated Total (Man-Hours Direct-Employment Only)	Per Cent of Total Man-Hours
Projects completed	137	5.6	$1,010,728	0.1	$2,855,512	$3,429,928	0.4	2,166,918	0.5
Projects under construction	664	27.1	429,710,748	55.9	295,774,660	504,856,423	55.1	241,280,002	54.1
Projects under contract	263	10.7	41,213,259	5.4	24,280,546	54,958,255	6.0	28,325,070	6.3
Projects being advertised	323	13.2	47,352,944	6.2	.....	64,609,988	7.0	30,379,135	6.8
Bond contract executed by administrators	554	22.7	152,615,724	19.9	.....	174,417,811	19.0	88,092,987	19.7
Bond contract executed on applicant	137	5.6	21,329,465	2.8	.....	25,246,818	2.8	11,645,250	2.6
Bond contract sent to applicant	274	11.1	47,791,200	6.2	.....	57,296,252	6.3	29,128,020	6.5
Projects allotted only	98	4.0	27,197,610	3.5	.....	31,710,123	3.4	15,673,660	3.5
Total	2,450	100	$768,401,678	100	$322,910,718	$916,525,598	100	446,691,042	100

TABLE IV—CASH DISBURSEMENTS BY PWA

On Non-Federal Allotments		
Loans and grants to public bodies	$114,883,475	
Railroads	46,854,000	
Limited-dividend housing corps	900,640	
Total, non-federal		*$162,638,115
Federal Allotments		
Highway construction	93,647,000	
River and harbor works	58,282,000	
Boulder Dam	6,873,000	
Tennessee Valley	6,865,000	
Other federal projects	96,753,000	
Total, federal		262,420,000
Statutory and Executive		
Farm Credit Admin.	62,850,000	
NRA expenses	5,248,000	
Civilian Conserv. Corps	185,570,000	
Civil Works Admin.	400,000,000	
Total, statutory and executive		653,668,000
Total disbursements		$1,078,726,115

*This is the amount deposited to the credit of applicants at Federal Reserve banks. Actual expenditures by applicants are estimated at $64,000,000.

Federal Power Commission is engaged in a broad investigation of electric utility rates and services, and the Coast and Geodetic Survey is undertaking an extensive study of earthquake stresses in buildings.

Effectiveness becoming apparent

There is much in the over-praised and over-criticized PWA program that does not meet the eye. It failed last fall and winter as a relief measure but now has become a significant element in the recovery program. Mr. Ickes, in his official statement relating to the first year of the PWA, said, in part: "Were it possible to condense the first year's achievements into a single phrase, relating to employment, it would be that the PWA program to date already has provided roughly one and one-half billion (1,418,000,000) hours of honest work at honest wages, on direct construction-site employment only, to men who otherwise would have passed those hours in the ranks of the idle. Approximately as many more (1,468,000,000) hours of direct employment in coming months are assured under PWA allotments, plans, specifications, and contracts which have already been made.

"And for each hour of direct employment on a PWA construction job itself, some two hours of "behind the lines" work is made possible on materials' production and handling in forests and factories, shops and railroads, mines and mills. There is to be considered also the general regenerative effect of vast payrolls, which means purchasing power for recovery all along the line.

"No simple citing of eloquent figures begins to tell the story of the first year of PWA. It is an agency that fights the battle for recovery on many fronts. It has won in many sectors, and lost in others. It has made errors, corrected its mistakes, and doubtless will make more errors to be corrected in their turn. But it is proving effective in bringing some fundamental changes in our economic condition which will be slower to be recognized than the more obvious physical public-works improvements."

Muskingum River Conservation Program Begins in Eastern Ohio

Design studies started on series of fourteen dams, to cost $34,000,000 and store 1,850,000 acre-ft. for $53,000,000 flood-control and conservation work in a district covering 8,100 square miles

By C. C. Chambers
Chief Engineer, Muskingum Watershed Conservancy District, New Philadelphia, Ohio

DETAILED engineering studies, preliminary to active construction work, have started on the $53,000,000 flood-control and water-conservation program of the Muskingum Watershed Conservancy District, comprising 8,100 square miles in southeastern Ohio. The project will include the building of fourteen regulatory and storage dams with supplemental channel work for flood control. The program is designed to relieve a flood menace in the Muskingum River Valley and to a lesser extent in the Ohio River below Marietta. In addition, the conservation work will augment water supplies in the area and materially improve sanitation conditions for waste disposal during low flow seasons.

Because the flood control and water conservation program in the Muskingum drainage area also will contribute substantially to the control of floods in the Ohio River Valley and will improve navigation on the Muskingum and Ohio Rivers, the PWA included the project in the public-works program and has allotted and transferred to the Corps of Engineers the sum of $22,090,000 to aid in financing its construction.

The Administrator has also provided for a loan of $500,000 to the district until the district is able to make levies on assessed benefits. This loan will be repaid to the government from levies.

Plan by U. S. engineers

The federal grant will be applied toward carrying out that part of the plan involving the construction of the main flood-control and water-conservation reservoirs. None of this federal money will be used to purchase reservoir rights-of-way or for relocation of highways, or any other work contemplated by the district.

The program of main reservoirs will be prepared cooperatively between the Corps of Engineers and the district, under the general direction and supervision of the U. S. district engineer and the chief engineer of the conservancy district. Except for the data on property benefited and damaged, the expense of preparing the official plan for the main reservoirs will be paid from the federal grant to the Corps of Engineers, and the detail work of preparing the plans will be under their supervision.

The plan, after approval by the Chief of Engineers and the board of directors of the district, must be made the official plan of the district, as provided for in the Ohio Conservancy Act. The plan will include the construction of fourteen dams and reservoirs, tentatively located as shown on the attached map, or corresponding reservoirs whose location and design may be agreed upon by the district and the Corps of Engineers, following a more detailed engineernig investigation.

The conservancy district has assumed the contribution of $12,000,000 toward the cost of these main reservoirs, to be used mainly for the purchase of reservoir sites and for the relocation of highways. The state of Ohio has appropriated $2,000,000 to the district to apply on this $12,000,000 contribution.

The state has also passed an enabling act which permits the director of the state highway department to enter into a contract with the district to carry out the relocation of all the highways in exchange for the benefits to the highway systems resulting from the building of this project. The cost of this highway work is estimated at about $4,000,000. The district will provide the remaining $6,000,000 by levy on the assessed benefits to real property. If the total right-of-way and highway relocation costs are less than $12,000,000, the remainder will be added to the federal grant for reservoir construction.

To provide complete flood-control protection for the cities and towns in the district, as contemplated in the com-

plete plan, the district must build supplemental local improvement works estimated to cost about $10,000,000. The ultimate plan also contemplates the construction of small reservoirs on tributary streams, primarily for water conservation and incidental flood-control benefits. No definite plans have been completed at the present time for financing this additional work.

District organization

The district was organized under the well-known Ohio Conservancy Act, by decree filed June 3, 1933. It comprises all or part of sixteen counties including the entire 8,038 square miles of drainage area of the Muskingum River and 288 square miles of Duck Creek, a small stream near the river. The act provides for a Conservancy Court composed of one common pleas judge from each county in the district. This court passes on the application and petitions for the creation of the district. When the district is created, the court appoints three persons as a board of directors, to act as business manager for the district.

In case of objections to the official plan or the appraisal record prepared by the board of directors, objections are heard by the conservancy court, which either approves, rejects or refers the plan back for amendment. The board, by force of the Conservancy Act, has the right and authority: (1) to enter into contracts or other arrangements with the federal government, (2) to issue bonds for the construction of the necessary works, and (3) to levy taxes and assessments on the appraised benefits after the appraisal record has been approved by the conservancy court.

PWA contract

An application for approval of the project and a request for financial cooperation from PWA was filed with the Ohio PWA advisory board as soon as that board was organized in August, 1933. The application was referred to Washington in September. The project was presented to the Mississippi Valley Committee in October. Late in December the project was approved by PWA, and the federal grant of $22,090,000 was allocated to the United States engineers, conditioned upon execution of a satisfactory contract between PWA and the district. This contract was achieved late in March, 1934. About the first of May the federal grant was made available to the Corps of Engineers for actual expenditure.

Funds and time were not available at the time the application was filed with PWA to complete a detailed engineering development of the project. It has been generally understood that more detailed engineering studies, foundation exploration and comparative estimates are essential before a sound design can be prepared.

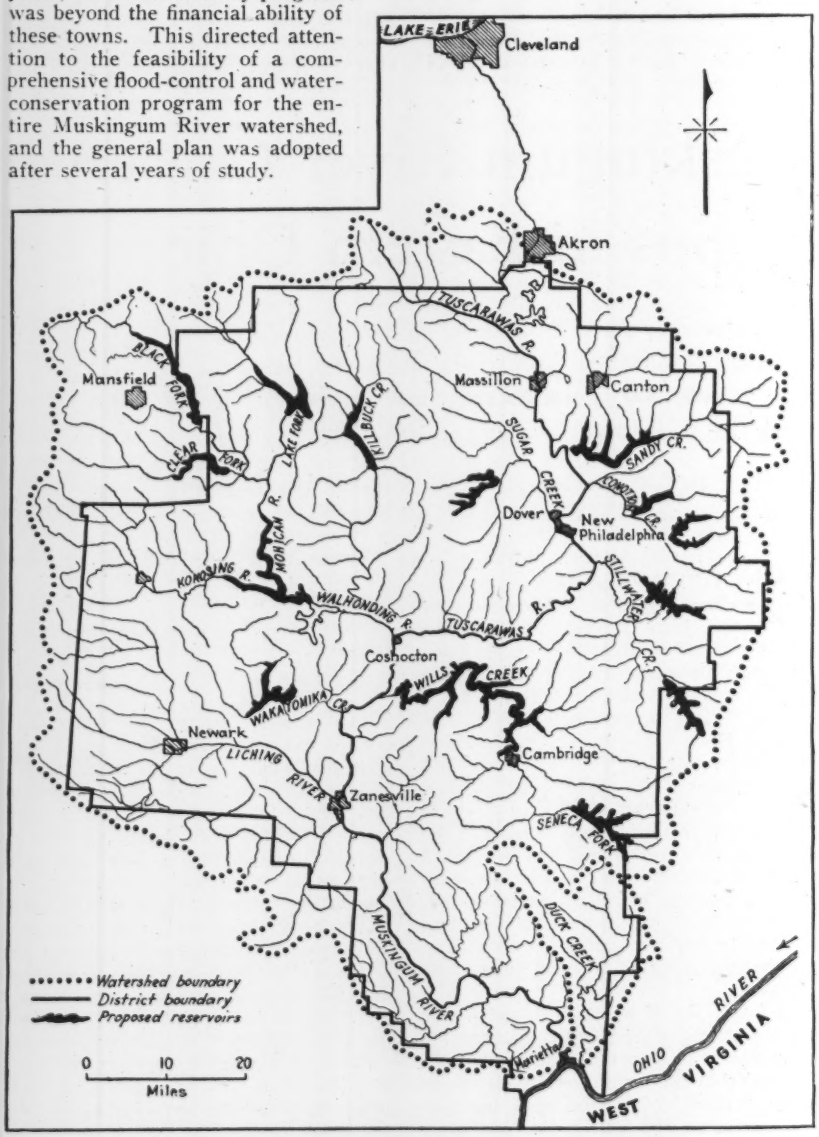
Immediately upon release of the federal funds to the Corps of Engineers, this body organized a large engineering force to complete detailed studies and the preparation of plans. Contracts were awarded for borings at all proposed dam sites and for aerial maps. From three to five boring rigs are now at work at every site.

Present plans call for the award of construction contracts so that work can be well started and carried on through the winter months. The awarding of construction contracts for the dams and relocations of public utilities will be under the direction of the Corps of Engineers.

The flood menace in this district, following the disaster in 1913 that resulted in the loss of eleven lives and heavy damages, has retarded rehabilitation and the development of the area. The local communities have studied the problem of adequate flood protection for several years, but the cost of any program was beyond the financial ability of these towns. This directed attention to the feasibility of a comprehensive flood-control and water-conservation program for the entire Muskingum River watershed, and the general plan was adopted after several years of study.

Since the cost of the program would obviously exceed the benefits that could be assessed within the district and, further, since the control of this stream would contribute materially to the control of Ohio River floods, it was evident that a wider spread of financing was essential and proper. It was on this consideration that the program was declared to be in part a federal project of the PWA.

The Muskingum project is somewhat novel due to the fact that it is among the first instances of cooperation between the United States government and a local subdivision of a state government in work of such magnitude and character. Federal officials have characterized the contract between the United States government and the Muskingum Watershed Conservancy District as a forerunner of other similar undertakings.



FOURTEEN RESERVOIR SITES tentatively selected to provide 1,852,000 acre-ft. of storage for flood control and conservation on the Muskingum River.

If it works well, it may serve as a model for other cooperative efforts between the national and local governments for flood control, conservation of natural resources, and social and economic improvements.

Watershed characteristics

The Muskingum River is a branch of the Ohio, draining about 8,000 square miles in eastern Ohio. The watershed area extends from its junction with the Ohio at Marietta north to within about 30 miles of Lake Erie (see map) and is about 90 miles wide and 120 miles long. The main headwater tributary is the Tuscarawas, with its source near Akron. This branch flows south and west about 110 miles to join the Walhonding and form the main river. From Coshocton, the Muskingum River flows in a southerly direction for a distance of 110 miles to Marietta, where it joins the Ohio River.

The slope of the main stream, in most cases, is gradual. The average fall in the 220-mile channel from the mouth of the Muskingum at Marietta to near the headwaters of the Tuscarawas is only 1.8 ft. per mile. Again, the average fall of Wills Creek in the 48-mile section above its mouth is only 1.5 ft. per mile. Above this section the slope increases to 5.7 ft. per mile. The Walhonding and Licking River branches have comparatively steeper slopes in the general range of 5 to 12 ft. per mile, along the latter river above Newark.

The Muskingum River has records indicating extreme variation in flow. During dry seasons the flow in the lower reaches of the stream often drops below 1,000 sec.-ft. and occasionally reaches a minimum of 400 sec.-ft. At the other extreme the record flood of March, 1913, produced a peak of about 300,000 sec.-ft. at Zanesville. Available records indicate that floods of damaging proportion may be expected to occur on an average of about five-year intervals.

Flood damage resulting from the 1913 flood is estimated to have exceeded $13,000,000 of direct loss to private, county and state property within the district. The intangible damage, including loss to business and industry, destruction of communication and transportation fatalities, plus the cost of flood-relief measures, is estimated at double this figure. Eleven lives were lost within the district, and hundreds were rendered homeless. Records indicate that more than $3,000,000 was spent by the counties and cities within the adjoining area for repairs of highways and bridges damaged by this flood.

The essential purpose of the district's program is to eliminate recurring flood damage. The results will stimulate development of the area, which has been retarded during the past two decades because of fear that the 1913 flood might be repeated. Although there are no large cities in the Muskingum flood area, many cities and towns with 40,000 population or less are situated along the river and its tributaries. In several cases these communities have a substantial part of their industrial and business section and some residential areas within the natural flood channels. Many of the railroads in this section are located in the stream valley, and the major highways are also subjected to damage in case of flood.

Ohio river floods reduced

The benefits of the flood-control program on the Muskingum River are not confined to the local watershed area. The Muskingum comprises 23 per cent of the Ohio River watershed above Marietta and more than 10 per cent of the drainage area of the Ohio above Cincinnati. With the proposed development reducing the flood peaks in the Muskingum by about 160,000 sec.-ft., the result will lower the crest of Ohio River floods by 6 ft. at Marietta. Naturally, the amount of flood-stage reduction will be less at points farther downstream, but for some flood conditions it is estimated that the Muskingum program will lower the flood peak at Cincinnati by 2 ft. The average annual flood damage on the Ohio River between Marietta and Cincinnati is more than $1,000,000. There will be appreciable benefit resulting from the Muskingum conservancy program in the flood-control problem of the Mississippi drainage area.

The complete plan for flood protection for the district provides for the construction of a series of reservoirs supplemented by the enlarging of river channels, elimination of obstructions, building of levees and other work necessary to provide adequate stream channels through the cities. The initial work to be constructed with the present federal grant tentatively includes fourteen main reservoirs with a total capacity of 1,852,000 acre-ft., and of this storage about 366,000 acre-ft. will be used for conservation, including river regulation water supplies, recreation and other uses. The remaining 1,486,000 acre-ft. is reserved for flood control.

In addition, the ultimate program provides for storage reservoirs on small tributaries with an additional 200,000 acre-ft. of capacity for water conservation, which will give incidental flood protection for local communities and will also reinforce the general flood-control program.

The complete program will provide 566,000 acre-ft. of actual reservoir storage as distinct from retention capacity. This river regulation will increase the low flow of the main stream by 1,500 sec.-ft. during dry periods and afford large benefits in matters of sanitation and stream pollution.

The tentative plan contemplates that five of the larger reservoirs, aggregating a capacity of about 1,000,000 acre-ft., will be built mainly for flood control and will be operated primarily for temporary retention. However, they will be manually operated by means of outlet gates at the dams, which will provide flexible control depending on the character of the flood, and will permit more direct regulation to reduce the peak. The result will permit practically complete control of the flood flow from the areas above the dams during the period of critical flood in the river.

Although the other nine reservoirs will combine features of flood control and water conservation, sufficient capacity will be reserved in the upper sections of these reservoirs to store a run-off of about 9 in. from the drainage area above each dam. Floodwater thus temporarily stored may be drawn down as soon as streamflow conditions below the dam permit.

Although the studies and borings have not progressed far enough to determine detail designs, it is expected that, with possibly one or two exceptions, the dams will be of earth construction, with concrete outlets and spillways founded on rock.

The development of hydro-electric power is not a factor in the program. This project is in the area of economic development of electric power by steam plants. River regulation will be beneficial to the location of such plants along the streams and near the coal deposits.

Soil-erosion study

The ultimate program for the district includes, among other things, a plan to check soil erosion, primarily to prevent reservoir silting and incidentally as an agricultural improvement. Two general methods are suggested: (1) the use of erosion-control methods on agricultural lands to prevent gullying and sheet erosion; and (2) the withdrawal of submarginal lands from agricultural use, allowing them to revert to forest.

The federal government has already established a soil-erosion project to cover the entire 92,000 acres of drainage area of Salt Creek, a tributary of the Muskingum River. Intensive studies and experiments will be undertaken on this drainage area to develop the best erosion-control methods for different types of topography and soils. This area was selected for an experimental field, since it contains many of the different soil conditions found in the Muskingum area.

The district has made application to federal departments for cooperation in the purchase and withdrawal of submarginal lands in which the federal government now has an interest. The district is also making arrangements to cooperate with other federal and state departments interested in the future development of these submarginal lands for forestation and park purposes.

The United States Engineers' Office has established a district office at Zanesville, Ohio, for the Muskingum area. This new office is in charge of Major J. D. Arthur, Jr., district engineer.

Training Civil Engineers to Meet Modern Demands

Increasing need for civil engineers in public service makes desirable a reorientation of the training of civil engineers—Unification of the construction industry under its code offers the profession new possibilities for service

By Thorndike Saville
Professor of Hydraulic and Sanitary Engineering, New York University, New York

THE ENGINEER, by applying scientific discoveries to the use and convenience of man, has been largely instrumental in making possible the economic and industrial era of the past three decades. But public opinion, while acclaiming the engineering achievements that have produced the machine age, holds also that these technological accomplishments bid fair to become a Frankenstein monster, destroying the civilization that created it. Production has appeared greatly to exceed consumption; machines to have supplanted the employment of labor; and engineering, as the basis of our economic system, is charged in part with the resulting debacle.

The inquiry is being generally raised, often almost as a demand, "Cannot the engineer apply his trained analytical faculties to the orderly appraisement of the social and economic factors as well as to the physical environment of our life?" Undoubtedly he can, and he has been doing so to an increasingly large extent during the past three years. However, the writer holds that the challenge to the civil engineer to become a force in public affairs is a peculiar responsibility and opportunity that warrants a serious reappraisement of his relation to the new order that is upon us and of his training for public service.

The students in mechanical, electrical and chemical engineering have had well-defined and often powerful industrial activities toward which to point their educational careers. Many of the larger industries have maintained educational departments, the duty of which was to contact with students in the non-civil engineering courses at universities and technical schools; to select the better graduates for their particular industry; to keep in touch with the teaching staff; and generally to stimulate engineering training for industry. In view of this situation it is not surprising that the reports and papers dealing with engineering education policies and curricula during the past decade in a great number of cases treat of a single theme having as its main objective: "How may engineering education better serve industry?" This thesis, with minor variations, is still the most popular and appears again and again in the publications of the Society for the Promotion of Engineering Education and even in strictly civil engineering periodicals. And by "industry" there is always meant the private corporations.

Not a recognized industry

The civil engineer has not had a recognized industry. He has of necessity become much more of an individualist than his colleagues in the other branches of the profession, and this in considerable part has been reflected in the differences in outlook upon public affairs and policies taken by the civil engineers. The majority of civil engineers have always gone into the public service or have acted for public agencies as consultants, designers or contractors. An analysis of the professional connections of the members of the American Society of Civil Engineers shows that at least three-quarters of the civil engineering profession is closely related to public-works activities, either as consultants, contractors and governmental employees, or in other fields such as public utilities and transportation invested with a large public interest.

Hitherto there has been no common objective on which to focus the education of the civil engineer for the public service to any such degree as there has been in industry for the other branches of engineering. The engineer rather than politician in public service has been a theme for some inspirational talks, but little has been done to formulate a professional consciousness and solidarity at all equivalent to that of industry. This has been due largely to four major causes: (1) the haphazard way in which engineers have been selected for positions in the public service; (2) a lack of coordination between different public agencies whose activities are largely civil engineering; (3) a highly competitive and poorly integrated construction industry; and (4) a lack of vision on the part of civil engineering educators in attempting to coordinate their curricula with the needs of public agencies, constructors and the private practitioner.

A great opportunity is now at hand for the profession of civil engineering to remedy most if not all of the handicaps under which it has labored during the past three decades of growth of the "industrial era." A new era is upon us, an epoch of different concepts of the relation of public to private activity; a time in which public works as planned, constructed and administered by the civil engineer have become part of an emergency program widely accepted and likely to continue in a modified form as a permanent national policy. The public is "public-works conscious." A large majority of capitalists, economists and labor leaders are in agreement that a public-works policy offers the best machinery for providing a regulator of employment and a balance wheel for business.

As part and parcel of this new public-works policy, the construction industry code has recently been formulated and approved. This, for the first time, makes a real construction industry and is capable of providing the civil engineer with an objective as well coordinated as those enjoyed by his electrical and mechanical brethren. The civil engineering profession must not fumble this opportunity. It is a public as well as a professional duty for the civil engineers to see to it that public-works activities and the construction industry shall be placed upon a sound basis as part of a new economic life.

Civil engineering responsibilities

What are the responsibilities of the civil engineering profession? Among others they relate certainly to promoting a proper public concept of the place of the engineer in public works, and to more adequate training of engineers and administrators for public-works activities. The first responsibility is primarily that of the professional engineering and allied societies, led, it is to be hoped, by the American Society of Civil Engineers. Some way should be found to create a self-consciousness akin to a distinct profession among engineers in or related to public-works activities, to the end that the fields of public work and construction may be as definite and objective on the part of the civil engineer as service with great corporations is to the electrical mechanical and chemical engineer.

The construction industry, highly competitive and disorganized, has in the past developed no policy for recruiting young engineers into its activities. It has had even less contact with engineering education than the public agencies directed and staffed by engineers. Now it bids fair to become far more unified, far better integrated to develop policies for its own development and functioning. It must be made to realize that it needs to attract young engineers trained to look upon construction as a career for which they have consciously prepared.

Engineers in federal service

There is no reason why public engineering agencies or the construction

industry should continue to hold aloof from an organized interest in engineering education. There is every reason why the major branches of each should follow the practice so advantageously developed by the electrical, mechanical and chemical industries described earlier in this article. The federal government is in an even more chaotic condition now than in the past with respect to selection of engineering employees, due to the large number of emergency agencies functioning under the Public Works Administration and with the regular government bureaus. Eventually such of these agencies as persist will, it is to be hoped, be better coordinated and permanently knit into a public-works organization such as the civil engineers have been advocating for years. It is not too early to begin planning for this, and in connection with it to propose sound procedures for recruiting the large technical staff required. There is no reason why a director of the engineering division of the Civil Service Commission should not have personnel experts who would visit the engineering schools, keep in touch with and consult about changes in curricula, interview students and help select graduates for specific federal activities. The type of mind required of a young engineer going into the U. S. Coast and Geodetic Survey, and possibly his training, should be materially different from that of one going into the Department of Agriculture or the Bureau of Public Roads. Similarly the larger state and municipal engineering departments ought to give much more constructive thought to the selection of engineers than is represented by the mere preparation of a civil service examination.

The construction industry has still farther to go. Its selection of engineering personnel is even more haphazard. It is not bound by civil service requirements. It ought to be able to pick the cream of civil engineering graduates and to promote in civil engineering curricula needed subjects in which undergraduates may now lack training.

Educational responsibility

On the other hand, there is a responsibility which is primarily that of civil engineering education. It seems clear that the fundamental background of the first two years of pre-professional work should remain. The study of economics, physics, chemistry and mathematics is essential to the "engineering mind." Emphasis must continue to be placed upon the development of the analytical faculties, the respect for facts, the intellectual honesty that is particularly the attribute of minds subjected to the scientific disciplines. Nor can we change much of the third year, containing as it does the general professional background of mechanics, hydraulics, materials of construction, etc.

It is in the fourth year where rather profound changes may be made without loss of a basic technical foundation. The present more or less standardized civil engineering courses given in the final year represent a sort of "shot-gun" course evolved to give some moderate training in whichever of the multitudinous civil engineering branches (structural, highway, sanitary, hydraulic, etc.) a student might chance to enter upon graduation. It gives neither adequate specialist training on the one hand nor adequate acquaintance with social and economic problems on the other. It certainly is not organized to fit the student for intelligent participation in the complex affairs of public works or the construction industry.

In attempting to face realistically the obligations of civil engineering education for the immediate future, it would appear that a logical procedure is to recognize that in the senior civil engineering year two major objectives should be adopted. The first is training for executive and administrative positions. The second is training for specialists: designers, operators and consultants. Both groups will be largely employed in the public works and the construction industry.

In proceeding to carry out these objectives, two facts must be realized: first, that at the end of his four-year course no student is capable of independent design of public-works structures; and second, that at least two-thirds of engineering graduates ultimately leave the strictly design and operative fields and enter into executive and administrative positions. If we realize that the progress of civil engineering in common with other branches of the profession has been so rapid and has developed into so many specialties that at the end of a four-year course the graduate has only a very meager specialist background, we may consider whether it is not possible to differentiate more definitely in the senior-year curriculum between prospective engineering executives and administrators, on the one hand, and specialists on the other.

Practicing civil engineers and others connected with public works and the construction industry have been increasingly appreciative of the need for more adequate consideration of major problems in economics and finance, as related to these fields of practice. With the importance of these subjects to be even more emphasized in the future, on account of the requirements of greatly increased funds devoted to public-works enterprises, it is essential that the civil engineering graduate have some adequate concept of the economic principles upon which the public-works policy is to be prosecuted: the methods of financing and of liquidating such projects, and the role of the engineer as financial advisor and executor, as well as designer and administrator.

If the young engineer is employed by a governmental engineering agency, he must deal with contractors who are engaged in construction activities. If he is employed by contractors, he should have some appreciation of the general problems of the industry, aside from the special technique as applied to a particular job on which he may be engaged. Young engineers generally have no adequate concept of the way in which contractor's operations are organized, of the problems related to bidding, of the equipment purchase or rental, or of relations between contractor and owner. With the development of new public-works policies, on the one hand, and of an integrated construction industry, on the other, it behooves the young engineer to give thought to these problems, whether he is employed by a public agency or private contractor.

Almost any engineering executive is bound to be brought into contact with the operation of new codes formulated under the National Recovery Act, particularly the construction industry code. As part of the code and otherwise, labor problems will always be an important element in any large public-works or construction project. It is essential that the engineer engaged in public works and construction should have a broad knowledge not only of the labor problems related directly to the code, but of the general theories and practices in handling labor.

The young engineer knows little about the many uncoordinated engineering activities of numerous governmental agencies, of how they are organized or how their engineering activities are carried on. And the adequate training for the public-works service must attempt to inform the young student on such matters.

These are matters calling for the serious consideration of our technical schools in the development of their engineering courses. As a specific example of how the problem may be met, the civil engineering faculty at the New York University has planned to introduce a public-works and construction option in the senior year in September, 1934. Five new courses are to be offered: engineering economics and finance, constructors' organization and equipment, construction codes and labor problems, industrial organization, and public-works principles and practice. To provide time for these courses, one of the technical courses will be omitted, and three others will be condensed. It is believed that the students may be given the basic principles of such subjects as structures, sanitary engineering and reinforced concrete, without the plethora of design problems now the practice. Student training for public works and the construction industry as careers will find in the condensed courses necessary information to acquaint them with modern principles and

practices. Those intending to specialize will take specialists' options, or may return for a fifth year of specialized post-graduate work. A considerable number of economists, labor experts, practicing engineers and government officials have agreed to give generously of their time in presenting various aspects of the subjects in the new courses.

Reappraisal needed

Just as industry and public agencies have had to alter profoundly their modes of functioning and their philosophy of procedure, so must the engineering colleges reappraise their responsibilities in training for a new economic order. Secretary of Agriculture Wallace, in a recent address before the American Association for the Advancement of Science, said in part:

"A characteristic of the engineer is his willingness to face the cold truth about the task to which he addresses himself. Engineers have brought to their jobs a more fully developed intellect than any other class of our citizenry. Sloppy, opportunistic thinking is simply inexcusable in the engineering world. I would be the last to suggest that the engineer abandon the precision of his thinking and his honesty in facing facts. I am merely asking that the same qualities be brought to bear in so far as possible on the more complex situations which have to do with living organisms and our social life."

One of the chief objectives in civil engineering training of the future should be to meet this challenge effectively.

Flood Probability Formula Modified to Simplify Application

A method of determining the probable 100-year floods based on the width of a drainage area and on rainfall statistics modified to improve it both practically and theoretically—Rainfall index for entire United States developed from runoff records

By C. R. Pettis
Lieutenant-Colonel, Corps of Engineers, U. S. Army, Columbus, Ohio

THE most convenient basic unit for computing flood probability is the probable 100-year flood, which may be defined as the most probable value of the maximum discharge in cubic feet per second that may be expected to occur at any specified station within any given period of 100 years. The probable 100-year flood corresponds to the duration curve value of the flood that will be "equaled or exceeded" once in about 250 years.

In 1927, in connection with a flood-control study at Wilkes-Barre, Pa., the author introduced a "width" formula for the probable 100-year flood at any given station. Most of the rivers considered at the time were in Pennsylvania and adjoining states, where rainfall conditions are fairly uniform and the general climate fairly humid. For the rivers considered the formula gave a much higher accuracy than any existing formula. The formula as then developed was as follows:

$$Q = CPW^{1.25}$$

in which

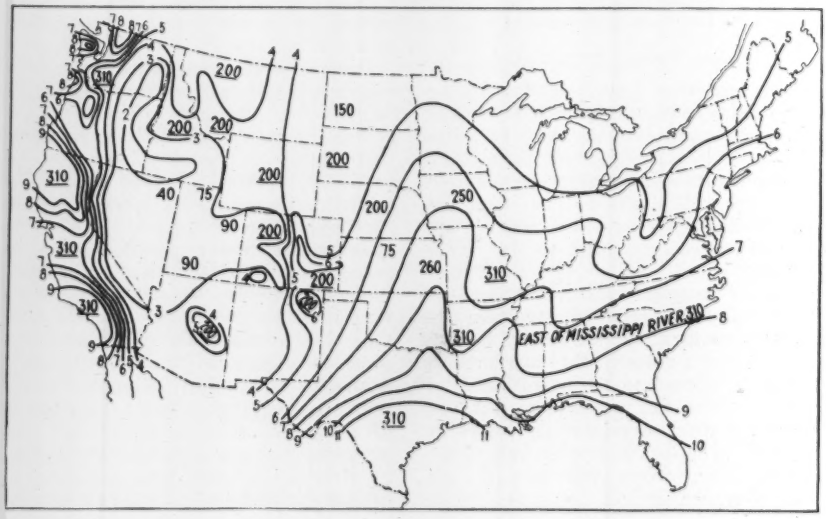
Q = discharge in sec.-ft. of probable 100-year flood.
C = numerical coefficient.
P = rainfall index.
W = average width of drainage area in miles.

In 1929 the author had an opportunity to make a detailed study of rainfall and runoff in Colorado, where the climate is semi-arid. This study indicated that the formula applies equally well in Colorado, provided the coefficient is suitably modified to accord with local rainfall conditions. As a corollary, it was evident that in any study covering the entire United States, floods should be segregated into groups based upon general rainfall characteristics. Since then the author has enlarged his study to include all official records of runoff published by the U. S. Geological Survey, in addition to unofficial records published in current engineering literature. The results of this study are here presented for the first time, together with a modification of the original formula.

In the original formula the rainfall index was based on a six-day rain. In the new formula the one-day rain is used. This change does not increase the accuracy of the formula, but it greatly simplifies the study of rainfall statistics. In the original formula the exponent of P was unity; in the new formula the exponent of P is 1.25, the same as the exponent of W. Theoretically this is correct, since P and W may be considered to be two dimensions of the cross-section of the unmodified prism of water that moves downstream. The old formula is almost as accurate as the new one for use with a group of rivers where the range of P is limited. The new form is better and more accurate for any study that involves a wide range of rainfall conditions.

Large storms produce correspondingly large floods only when the ground is comparatively wet at the beginning of the storm. In this case there is a direct relation between the storm precipitation and the river discharge, which can be expressed by a formula. By means of the formula we can express any discharge in terms of the precipitation that was necessary to produce it; and this enables us to compare the discharge at different stations in any section where the runoff characteristics are similar. The known relation between precipitation and runoff is an advantage in a study of runoff, because the information about precipitation is

ISOPLUVIAL LINES in the United States for the probable 100-year, 1-day rainfall, in inches. The large numbers on the map are numerical coefficients for use in the "width" formula for determining the probable 100-year flood. The numbers not underscored are doubtful, due to insufficient records in the particular localities.



generally more complete than the information on runoff.

The pluvial index used in the formula is based on the probable one-day 100-year rainfall. The accompanying chart, for the eastern United States, is based on a similar chart of the Miami Conservancy District. For the western part of the country the basis is a chart that was prepared by F. G. Switzer and H. G. Miller, of Cornell University. The chart has been modified to make it conform to additional information that is available. Further detailed revisions are desirable, especially in the mountainous regions of the West.

The total number of record years considered is about 20,000. On the basis of one 100-year flood for each 100 record years, there are of record in the United States about two hundred 100-year floods. Except for some of the arid portions of the West, where the records are inadequate, there is in general a good statistical basis for studies of runoff.

New width formula

The new width formula, developed as a result of the studies previously outlined, is:

$$Q = C\,(P\,W)^{1.25}$$

in which

Q = crest discharge of probable 100-year flood in cubic feet per second.

C = coefficient which varies in different sections, principally in accordance with aridity; to some extent with topography (prairie).

P = rainfall index from the accompanying chart; the probable 100-year one-day rainfall in inches.

W = average width of drainage area in miles.

The average width W is obtained by dividing the drainage area in square miles by the length of river, in miles, above station. Measure the length of river on map, scale about 10 miles to inch, neglecting minor sinuosities. The length that is thus conveniently obtained is slightly less than the actual length of streamline.

Large storms, of the type in question, seem to show an invariable tendency to increase gradually and somewhat irregularly to a decided peak, and then to subside gradually. It can be assumed, as a rule, that a large part, generally about two-thirds, of the rain will fall in a 24-hour period. As a general principle it can be stated that the crest discharge at any station will occur when the water that is passing the station includes that which fell on the widest part of the drainage area above the station during the peak of the storm. It is convenient to visualize the flood wave as a prism of water moving downstream. Valley storage tends to flatten out the flood wave, and make its crest cross-section proportional to the average width, instead of the maximum width of drainage area. The cross-section of the flood prism at the crest will thus be proportional to PW, where P is the depth of rain and W the average width of drainage area. If we assume that the general slope remains the same at a given station, and that the cross-sections are similar figures, it follows from the Chezy formula that for different floods the discharge will vary as the 1.25 power of the cross-sectional areas. The width formula conforms to the given assumptions. This explanation is brief and therefore incomplete, but it may serve to indicate that the width formula is rational.

Limit of applicability

This discussion is limited to drainage areas between 100 and 40,000 square miles. Drainage areas over 10,000 square miles generally have a slightly smaller flow than indicated by formula. In areas under 1,000 square miles the probable rainfall is slightly higher, but the cumulative effect of the storm is less on a small area; and these two conditions tend to compensate for one another.

The formula applies directly only for uncontrolled flow. A natural lake controls the flow for all of the drainage area above it. Topography has no effect provided the greater part of the drainage area can be classed as gently rolling hills to mountainous. Fairly level prairie land has a decreased flow because the flow is retarded in a way that is equivalent to control, and some seepage occurs. The formula with coefficient $C = 310$ seems to apply to practically all rivers east of the Mississippi River, except those in the level coastal plain, in the Mississippi River overflow plain and in the level prairie country of Illinois. In the prairie country the flow corresponds to a coefficient about one-third of that given above.

Unusual shapes of drainage basin may affect the discharge. If the drainage area is pear-shaped, with the large end near station, the discharge will be somewhat greater than indicated by formula. If the drainage area is pear-shaped, with the small end near station, the discharge will be less than shown by formula. It is unusual for this characteristic to cause a variation of more than 15 per cent in the discharge. A few unusual shapes are found where the variation is greater.

The values of C to be used in the formula are shown by numbers on the chart. Where the numbers are understood, a sufficient number of records were found to justify considerable confidence in the determination. The numbers that are not underscored are doubtful, due to insufficient records in the particular localities. All of these doubtful figures could undoubtedly be improved by more detailed studies made on the ground.

For the humid regions east of the Mississippi and along the Pacific Coast, $C = 310$. The only group of rivers east of the Mississippi showing a different value of C is in the level prairie region of Illinois, where $C = 100$.

For the semi-arid Rocky Mountain region, of which Colorado is typical, $C = 200$.

There are not sufficient records in the great plains region east of the Rockies for a satisfactory determination of C. Local conditions and topography probably have considerable influence in this region.

This study is based on conditions that accompany the larger storms. In all parts of the country there may occur cloudbursts in which the precipitation over a comparatively small area may be two or more times that indicated by the chart. Based on available records, the formula is safe for areas of more than 1,000 square miles. The chance of a cloudburst occurring on any specified small area is slight, except possibly in a few mountainous localities where local topography is favorable for the phenomenon.

The 100-year flood is inadequate for the design of some engineering works of importance. The following statements are based on a statistical consideration of the evidence available. The probable 1,000-year flood is about 20 per cent greater than the probable 100-year flood. The probable 10,000-year flood is about 30 per cent greater than the probable 100-year flood. The maximum flood of authentic record (20,000 years) is about 35 per cent greater than the probable 100-year flood.

It is evident from the above that the width formula meets statistical requirements in a satisfactory and logical manner.

German Land-Development Law

Development of suburban property in Germany for home sites is to be under government supervision as a result of a new law recently passed, according to a report to the U. S. Department of Commerce. The legislation is designed to prevent persons from cutting up surburban property into lots and selling them with the sole thought of personal gain and no consideration of the public welfare. Hereafter, proposed developments must have the approval of high government authorities. This approval will be given only if the plans take into consideration such factors as requirements of industry, traffic, recreation and the conservation of the beauty of the surrounding landscape. Areas cannot be developed if the cost of building roads, water systems and other improvements would be disproportionately high. The authorities can require the owner of the property to cede to the city gratis up to 35 per cent of the entire area for streets, recreation grounds and other public purposes.

STABILIZED SOIL-BOUND ROAD SURFACES

IV—Construction and Maintenance Costs

Actual construction costs on Michigan roads critically analyzed and, from them, estimates deduced of comparative maintenance costs

By W. R. Collings and L. C. Stewart
Road Stabilization Department, The Dow Chemical Company, Midland, Mich.

PRECEDING ARTICLES on theory, traffic tests and construction of stabilized soil-bound roads find justification for their length in the records of construction and maintenance costs that follow. These figures are from actual roadbuilding operations. As presented with critical discussion, they are indicative of the economics of stabilization.

To determine the place of stabilized soil-bound wearing courses in any low-cost road program, the following three questions must be answered:

1. What is the cost of the improvement?
2. What are the comparative maintenance costs of the improved type as compared with the ordinary traffic-bound road?
3. What is the annual value of the improved, tightly bound, dustless riding surface?

Having the answers, the economic soundness of any particular project is determined by the equation: maintenance savings plus the value of the improved service must equal the cost of the improvement in a reasonably short time.

Cost of stabilization

Most of the projects on which detailed cost records have been kept have involved the stabilization of established gravel roads by treatment with clay, scarifying and mixing of old road material with the added binder. No similar cost figures are available at this time for new construction or resurfacing projects. However, the cost per mile of stabilizing for the same depth of wearing course on new construction or resurfacing projects will not differ greatly from the cost per mile of stabilizing established gravel roads. The operations are practically identical, except that scarifying is not generally required on new construction. Of course, whenever new aggregate is to be used, either because the old road metal is too thin or for other reasons, the cost of such new material should be considered separately from that of stabilization.

FIG. 1—BEFORE stabilization, a rutted sand-soil road is a difficult road to travel under any circumstances.

The largest items of expense are usually the cost of the clay and its preparation. In a paper presented at the Purdue Road School, W. O. Dow, engineer of Grand Traverse County, Mich., presented detailed costs that serve very well to show the expense of delivering and preparing clay. The complete figures are given in Table I, in which all of the first five items that are listed relate to the cost of clay.

Item 1 gives the cost of the clay bought at 10c. per cubic yard, the price that is usually paid the land owner.

Item 2 shows the cost of loading the clay, using a power shovel. The figures show that 222 cu.yd. of clay was the average amount needed per mile of road, and that the cost of loading was nearly 16c. per cubic yard. On other projects outside this county, loading costs as low as 8c. per cubic yard have been obtained, using a power shovel, while hand-loading has cost from 25 to 60c. per cubic yard.

Item 3, the average cost of hauling the clay, was around 32c. per cubic yard. In general, this cost varies from 5 to 10c. per cubic yard per mile, depending on the distance of the clay from the project and on the prevailing haulage rates.

Items 4 and 5, the cost of spreading and pulverizing clay, did not vary greatly from job to job. The expense of the machine work for handling the operations is included. Any extra working of the clay, such as that which is sometimes required when the drying is interrupted by rainy periods, will raise the cost of these operations somewhat.

Item 6—scarifying, mixing and shaping costs—ranged from $24 to $62 per mile. This cost, likewise, varies somewhat with the weather conditions that are encountered. The relatively high cost of these operations on the Garfield Road was due to the wet fall weather during which the work was done, while

the low cost on the Acme-Williamsburg project can be credited to dry weather. The greater length of the latter project (8.6 miles) was probably an additional influence in decreasing the cost.

Item 7—removal of oversize stone—is now considered an essential part of the stabilization work. The only other project on which a reasonably thorough job of stone removal was performed, and on which a record of this cost is available, was carried out by the Michigan State Highway Department in Ingham County, Mich. ("Stabilizing Michigan Roads with Clay and Calcium Chloride," *Public Works*, December, 1933.) The cost of raking and removal of oversize stone was about $38 per mile on that project, as shown in Table II. In both cases, mechanical rakes were used to remove the material to the side of the road, where it was loaded into trucks with forks.

Item 8 relates to the cost of sprinkling, and is likewise a desirable refinement in stabilization work that has been used on a number of projects. The costs given here are about the average expense for this work, as this item will generally range between $25 and $50 per mile. It depends on the length of haul and the quantity of water required, both of which are subject to wide variation.

Item 9—calcium chloride and its application—is rather low in cost in the cases listed. In general, at least 3 tons per mile, 16 ft. wide, should be used. The cost of this quantity, applied, will range from $65 to $90 per mile.

Some other interesting figures were obtained by analyzing the averages that are given in the table: (*a*) The cost of materials was $22.25 per mile for clay at the pit and $49.44 for calcium chloride, a total of $71.69 per mile. The rest of the total cost, $203.94, or 74 per cent of the total, was spent entirely for local labor, equipment rental and equipment operation. (*b*) The sum of items 1 to 5, which cover the complete cost of the clay, delivered, dried, pulverized and ready for mixing with the aggregates, amounts to $149.73 per mile. Dividing this figure by the average quantity used, 222 cu.yd. per mile, gives a cost for pulverized clay on the road of 68c. per cubic yard. (*c*) The cost of the clay prepared in this way was more than half the total cost of the projects.

TABLE I—STABILIZATION COSTS PER MILE OF GRAVEL ROAD
GRAND TRAVERSE COUNTY, MICHIGAN

Road Item	Garfield 2 mile	County Line 3 mile	Acme-Williamsburg 8.63 miles	Silver Lake 5.5 mile	Secore 2 mile	Average
1. Clay, in pit (10c. per cu. yd.)	$15.60	$9.00	$18.80	$26.00	$28.60	$22.25*
2. Loading clay	46.85	12.55	22.40	36.25	34.44	34.98*
3. Hauling clay	98.40	20.73	57.60	65.70	57.90	69.90*
4. Spreading clay	12.15	8.15	10.10	16.50	9.73	18.12*
5. Pulverizing clay	11.10	10.76	7.82	12.20	10.50	10.48
6. Scarifying, mixing and shaping	62.52	33.86	24.00	53.10	41.06	42.91
7. Stone removal	.....	.....	.....	8.60	36.45	.....
8. Sprinkling	.....	.....	.....	33.00	34.10	33.55
9. Calcium chloride (applied)	.....	58.51	46.30	44.20	48.75	49.44
Total	$246.62	$153.56	$187.02	$295.55	$301.53	$275.63†

*Costs from County Line project omitted because thickness of stabilized course was only 1.5 in.; other projects were 3 in.
† Average, exclusive of cost of removal of stone. Width of stabilized wearing course was 20 ft. on all projects.

TABLE II—STABILIZATION COSTS PER MILE OF GRAVEL ROAD,
MICHIGAN STATE HIGHWAY DEPARTMENT

County	Barry	Bay	Cass	Ingham	Midland (1)	Midland (2)	Average
Length, miles	10.5	2.3	7.0	7.4	10	6	.....
Clay required per mile, cu. yd.	195	240	200	170	210	150	194
Clay cost, delivered	$155.95	$318.00*	$155.10	$162.78	$59.90	$121.60	$162
Clay drying and pulverizing	10.05	21.42	11.83	12.57	21.05	85.50†	27
Scarifying, mixing and shaping	39.60	22.65	55.03	59.83	48.05	26.90	42
Oversize stone removal	.....	.....	.....	37.33	13.20	6.25	9
Misc. charges	.....	.....	8.80	24.39	.....	.....	6
Sprinkling	.....	.....	.....	25.03	.....	.....	4
Calcium chloride applied 2½ tons at $25	62.50	42.00	44.50	59.20	66.90	71.60	58
Total	$268.10	$404.27	$203.43	$381.13	$208.20	$311.85	$308

*Clay shipped from a neighboring county by rail.
†Includes shoulder trimming, mixing with loose gravel and shoulder material.

It is worthy of note, however, that the average total cost of pulverized clay was $189 per mile, or 84c. per cubic yard on these projects, as compared with $149 per mile and 68c. per cubic yard on the Grand Traverse County work. The average cost for scarifying and mixing was $42 per mile, almost the same as the average for the projects listed in Table I. The average total cost of the state work, $308 per mile, exceeded that of the county projects by only $33.

FIG. 2—AFTER stabilization, a soil-bound road becomes one of the smoothest and most resilient travel surfaces.

Comparative costs

The maintenance costs of surfaces of the traffic-bound type usually consist of three main items: (1) scraping expense, (2) replacement of material lost from the road surface, and (3) the cost of calcium chloride where it is used.

Based on information given by W. O. Dow in the paper already mentioned, it is safe to assume that annual scraping costs will be reduced 50 per cent or more by stabilization. Little information is available of the quantity of material that is required to replace losses

TABLE III—ESTIMATE OF SAVINGS PER MILE TO BE OBTAINED FROM STABILIZATION OF ORDINARY TRAFFIC-BOUND ROADS

1	2	3	4	5
Traffic Count	Approximate costs of maintenance of unstable traffic-bound road surfaces	Minimum estimated savings resulting from stabilization	Annual cost calcium chloride after stabilization at $25 per ton	New annual savings per mile after deducting cost of calcium chloride
250–500	$250 to $500	$125 to $250	5 to 7 tons $125 to $175	0 to $125
500–1,000	$400 to $800	$200 to $400	6 to 9 tons $150 to $225	$50 to $250
1,000–1,500	$600 to $1,000	$300 to $500	8 to 10 tons $200 to $250	$100 to $300

on unstabilized traffic-bound roads. A study made in Indiana several years ago (Highway Research Board, Eighth Annual *Proceedings*, p. 227.) indicated that the amount was about 30 cu.yd. annually per mile per 100 vehicles daily traffic. On this basis, with a traffic count of 500 vehicles per day, a loss of 150 cu.yd. of surface material would occur annually. Strahan (*Public Roads*, Vol. 10, Sept. 1926, p. 135.) made extensive studies of this subject on sand-clay and sand-clay-gravel roads in Georgia over the period of five years between 1922 and 1927. The results did not indicate such a direct relation between traffic count and loss of material. The quantities lost, as determined by depth measurements taken at a large number of stations, ranged from ½ to 1 in. annually with a traffic count between 400 and 500 vehicles per day. This amounts to a yearly loss of 200 to 400 cu.yd. per mile per 20-ft. width of road.

Stabilization of sandy and loose gravel-type wearing courses with calcium chloride and soil binder reduces loss of materials, first, by holding aggregate particles in place securely. This prevents their destruction by abrasion under traffic and maintenance operations and prevents their removal by suction and centrifugal action of traffic; at the same time the dust hazard is eliminated. Second, by limiting the penetration of water in wet weather, thus preventing loss of appreciable quantities of fine surface material by washing rains.

There are many places where the value of an improved road is of greater importance than the actual maintenance savings involved. This is particularly true in resort districts where frequently the seasonal traffic is heavy, but the annual traffic count may be rather low.

Maintenance savings

Tables I and II show that the total cost of a number of projects ranged between $200 and $400 per mile. If a road is to warrant this expenditure on the basis of maintenance savings, the reduction in annual cost that is to be expected should amount to about $75 or more for a $200 expenditure, and $150 or more for a $400 expenditure. Based on the preceding discussions in this article, a reduction of at least 50 per cent can be expected in both the cost of scraping and of surface-material replacement. On traffic-bound roads carrying 500 vehicles or more, an annual maintenance saving of this size will pay almost invariably for the annual cost of the calcium chloride that is required for surface treatment. In addition, a balance will often remain from the maintenance savings which will pay for the initial cost of stabilization in two or three years.

The way in which the maintenance savings that result from stabilization of ordinary traffic-bound road surfaces may be expected to pay for the cost of the improvement is shown in Table III. Figures are presented in the first column for three ranges of traffic density.

Column 2 shows the approximate range of surface maintenance costs, including scraping and gravel replacement, for ordinary traffic-bound roads.

Column 3 shows the minimum estimated reduction in cost of scraping and gravel replacement that would result from stabilization. These were obtained by taking 50 per cent of the maintenance costs listed in column 2.

Column 4 shows the cost of calcium-chloride treatment after stabilization. The smaller figure is deducted from the savings listed in column 3 to give the range of values for the annual net savings that would result in these cases. These figures, listed in column 5, indicate the money that would remain from the original maintenance costs to pay for the improvement, or the earnings per mile of the stabilization investment.

Indiana Widens Shoulders on 1,000 Miles of Road

State highway maintenance department carries out $3,000,000 PWA project by day labor—Employment reaches peak of 35,000

WITH a $3,000,000 PWA loan fund, of which 30 per cent is a direct grant, the state of Indiana is building additional safety, service and beauty into 1,000 miles of its state highway system by extending the roadway to full width of new right-of-way lines and by widening the shoulders as much as possible under varying local conditions. Both cuts and fills are being extended to the limits of right-of-way, and the entire area between top of fill slope, or drainage ditch, and the road surface is being built up as shoulder. The program, in which a peak employment of 35,000 was reached, is being carried out by day labor under the direction of the state highway maintenance department. At present the widened shoulders are being fertilized and seeded, though the department hopes to treat a 2-ft. strip on each side of the surfaced area with some kind of road metal in the near future. In this program the road surface is not disturbed or widened. Additional land is being purchased to extend the right-of-way of all roads in the project to a minimum width of 80 ft. and to 100 ft. wherever practicable. Funds for right-of-way purchases are supplied from the regular departmental budget and are not taken out of the PWA loan fund. Once the program got under way and the adjoining property holders

WIDENING SHOULDERS on one of Indiana's trunk highways. Roadway is extended to full width of 100-ft. right-of-way, and shoulders are widened out as far as possible under local conditions.

BUILDING SAFETY into Indiana roads by widening the shoulders. New shoulders in foreground are in contrast with the former narrow strips indicated by guard-rails in background, yet to be moved.

realized what was being done, right-of-way purchases became easy, and in many cases the necessary land was donated.

The shoulder-widening project was conceived and carried through the financing stages by J. D. Adams, chairman of the state highway commission, primarily in the interests of safety and unemployment relief. The commission is greatly disturbed over the number of serious and fatal accidents attributed to narrow shoulders. Even though the project is not yet completed and covers only 11 per cent of the state highway system, hundreds of reports have been received by the commission of potentially serious accidents averted by the presence of the wide shoulders. The psychological effect of driving alongside a smooth wide shoulder is believed by the commission to avert many accidents.

Besides the safety and employment features of the program, the commission points out several other advantages, including reduced cost of maintenance, reduction of snow drifts and easier handling of snow, the providing of a roadway for the movement of heavy farm equipment, space for pedestrian traffic, opportunity for roadside beautification and the ease with which future widening of the wearing surface could be carried out. This last item is considered of importance in planning future improvements to accommodate increasing traffic.

The maintenance department is divided into six districts, each in charge of a district engineer. The total fund was allocated to these districts and then distributed to road sections varying from 6 to 8 miles in length and covering 79 of the 92 counties in the state. Most of the sections selected for improvement are on the primary system. Careful estimates were made of the cost of work for each section, and in actual prosecution of the work these preliminary estimates were found to be remarkably close, with very little redistribution of funds required.

With employment as one of the primary features of the program, hand labor is used wherever possible to good advantage. In general, the material required for widening fills can be obtained from near-by cuts, though some borrowing and waste is unavoidable. All kinds of equipment is being used, most of it belonging to the maintenance department, though some is rented as needed. Tractor-hauled graders are widely used. In connection with this equipment, material is spread and trimmed by hand, and final sloping of banks is by hand.

In some instances teams are used to handle slip scrapers on short hauls and wagons for greater distances. Trucks are being employed where the length of haul is considerable. Wagons and trucks are usually loaded by hand, though power shovels are employed where the excavation is heavy.

All labor is recruited locally from federal relief lists. The rate of pay is 50c. per hour, 30 hours per week. The men supply their own transportation and hand shovels. Supervision of the gangs is by regular maintenance superintendents and foremen of the maintenance department. Although the program put a tremendous amount of additional work on the regular department, all accounting, clerical work and engineering was handled without extra help.

Culverts and other small drainage structures are being extended under separate contracts. Drainage pipe and tile are being installed where required. Large bridges, except those being replaced in the regular highway-betterment program, are not being widened.

After the shoulders have been completed, they are fertilized with an ammonium phosphate solution delivered to the job in the department's distributor tanks. This material is applied with flexible spray nozzles attached to the tank. Then the shoulders are seeded by hand with a mixture of timothy, red-top clover, blue grass and lespesdeza. Small trees, supplied by the highway department nursery, are being set along certain sections adapted to beautification of this kind. In the northern sand belt limestone screenings are added to the shoulders to permit seeding with sweet clover and alfalfa.

Work on the project started last December and will be completed by August. At present the force has dwindled to 4 000, but will be built up during the summer months. During the past spring several CWA projects of similar nature were carried out in addition to the PWA program. At present one transient-relief widening project and several FERA widening projects, in addition to the original work, are under way.

The work is being carried out under the direction of C. W. McClain, maintenance engineer, and C. W. Siniff and E. B. Lockridge, field engineers of maintenance. Under the six district engineers the following maintenance engineers are in direct charge: M. J. Stinchfield, Fort Wayne; George T. Chapman, Greenfield; Lester L. Walker, Seymour; F. E. Bernoske, La Porte; Frank Conley, Crawfordsville; and N. F. Schafer, Vincennes.

NARROW GRAVEL ROAD being made safe by shoulder-widening. Most of the widening is being done on one side to preserve the row of fine trees shown at left.

Bouquet Canyon Dam Built for Los Angeles Aqueduct

Rolled earthfill dam 185 ft. high provides 36,000 acre-ft. of intermediate, off-the-line storage to replace that lost with the failure of the St. Francis Dam—Reservoir fills and discharges through 3½-mile welded-steel pipe line

By H. L. Jacques
Construction Engineer, Bureau of Waterworks and Supply, Los Angeles, Calif.

TO PROVIDE additional storage along the Los Angeles Aqueduct for water-supply emergencies and to equalize the flow for better power production, the department of water and power has just completed the Bouquet Canyon Dam. The 36,000-acre-ft. reservoir site is located about 50 miles from Los Angeles on a small stream with negligible runoff and will be filled and discharged through a 3½-mile steel pipe line connecting with the aqueduct at the head of the penstock to San Francisquito No. 1 power plant. The 185-ft. dam, containing about 3,000,000 cu.yd. of rolled earthfill, and the pipe-line construction over rugged country were the major features of the $4,000,000 development.

The 240-mile aqueduct from Owens Valley supplies a major part of the water supply for Los Angeles and also operates five power plants. On this aqueduct system the St. Francis Reservoir provided about 38,000 acre-ft. of important regulatory and reserve storage. With the loss of that storage capacity in 1928, it became essential to replace it in about the same volume and location. After considerable study the present site in Bouquet Canyon was selected as best suiting conditions.

Relation to aqueduct

Bouquet Canyon is on a small tributary of the Santa Clara River, and the dam site is 17 miles northeast of the town of Saugus near the headwaters of the stream, where the catchment area is only 13.6 square miles. The site is about 4 miles east of the aqueduct line at the position of the first power drop. Thus, although the natural runoff behind the dam is small and will not be utilized, the relative location and elevation of the 36,000-acre-ft. reservoir site permitted it to be connected to the aqueduct by a pipe line that could be cut in or out of the aqueduct flow to provide invaluable floating storage (Fig. 1).

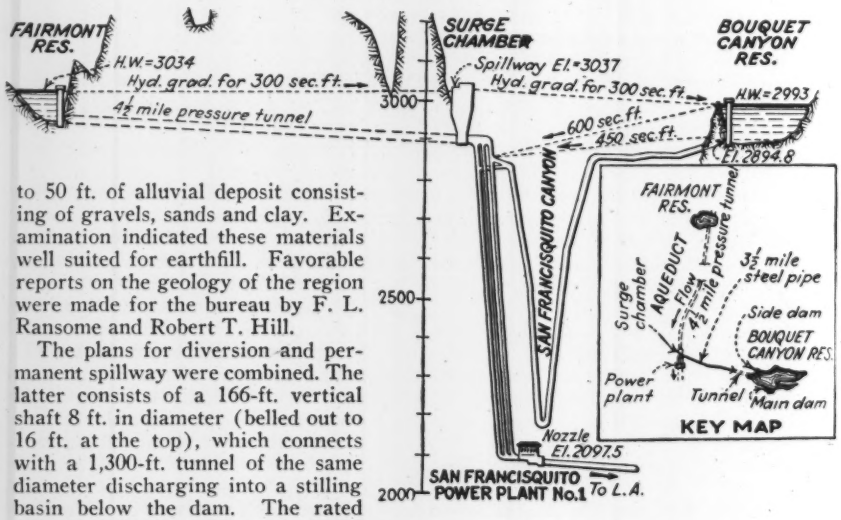
The underlying rock formations in the reservoir site are covered with 10 to 50 ft. of alluvial deposit consisting of gravels, sands and clay. Examination indicated these materials well suited for earthfill. Favorable reports on the geology of the region were made for the bureau by F. L. Ransome and Robert T. Hill.

The plans for diversion and permanent spillway were combined. The latter consists of a 166-ft. vertical shaft 8 ft. in diameter (belled out to 16 ft. at the top), which connects with a 1,300-ft. tunnel of the same diameter discharging into a stilling basin below the dam. The rated capacity of the spillway is 1,600 sec.-ft. Upstream from the bottom of the shaft the tunnel was extended as an 8x8-ft. horseshoe section 600 ft. to a portal in the reservoir site to handle natural streamflow during the construction period. After completion of the dam this diversion tunnel was plugged with concrete upstream from the shaft. A 24-in.-diameter steel pipe was laid through the entire length of tunnel to act as a bypass and allow the discharge of the equivalent of the natural flow from the watershed.

The tunnels were driven through schist of varying hardness, which required light timbering of 8x8-in. sets at 5-ft. centers for most of the 1,900 ft., although there was no real heavy ground. Using two drifting drills mounted on a horizontal bar, the tunnels were driven full section. Holes per round varied from 10 to 22, depending on the hardness of the rock. To avoid excessive overbreak, short rounds of 5 ft. were pulled, using 40 per cent powder.

Mucking was done by hand into 40-cu.ft. cars that were handled by air or electric hoist. The shaft was raised to the surface from the tunnel elevation in a 6x8-ft. section and then trimmed to final size from the top down. Both tunnel and shaft are lined with reinforced concrete.

FIG. 1—SCHEMATIC DIAGRAM showing relation of Bouquet Canyon Reservoir to Los Angeles Aqueduct system.



The main structure is a rolled earthfill dam of conventional design with a height of 185 ft. above streambed, a crest length of 1,200 ft. and side slopes of 3 to 1 on both faces. The principal dimensions and characteristics are shown in Fig. 2. The upstream face is paved with a reinforced-concrete slab 6 in. thick at the crest and 9 in.

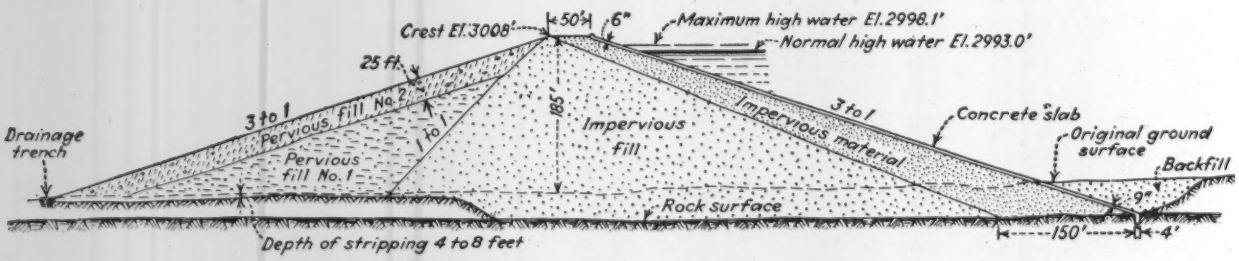


FIG. 2—MAXIMUM SECTION of Bouquet Canyon Dam, indicating various classifications of the earthfill.

thick at the base, where it connects with a concrete toewall 4 ft. thick extending from 10 to 20 ft. into firm bedrock. This paving is designed primarily for protecting the fill against wave action.

The schistose rock at the site is covered with 30 to 40 ft. of sand and gravel overburden in streambed, and on the abutments there is a deposit of 3 to 8 ft. of sandy clay. Exploration of the site was extensive and included drill holes along both toes and the axis, aggregating 1,319 ft., supplemented by four shafts with a combined depth of 229 ft. through the alluvial fill into bedrock and fourteen drifts aggregating 853 ft. into the abutments. The material developed by these explorations was used by the board of consulting engineers and geologists.

Stripping of the site included the removal of all unconsolidated material to bedrock from the upstream toe to the downstream limit of the impervious fill, or a distance of 800 ft. along the streambed. Not only was the loose overburden removed, but the weathered and weak rock was stripped, including all that could be loosened by steam shovel without blasting.

Downstream from this complete stripping, the sand and gravel in the streambed were removed to a depth of about 3 ft. to eliminate all brush and roots. Along the abutments the foundation was stripped to rock from face to face. Machine stripping was followed by hand work immediately prior to the placing of the fill to insure complete removal of loose or weathered material.

Stripping involved the removal of about 800,000 cu.yd. of material, and of this volume 443,000 cu.yd. was deposited in the downstream or pervious section of the fill; 50,000 cu.yd. was used to build the diversion dam, and the remainder was wasted below the dam site or used for road construction. Streambed excavation averaged about 40 ft. deep, and about 20 ft. of stripping was taken from the abutments. This material was handled by power shovels and trucks, supplemented by crawler wagons hauled by tractors during wet conditions.

The impervious section of the fill extends from the upstream face to a plane sloping downstream 1 to 1 from the downstream edge of the crest. This part of the structure represents about 75 per cent of the entire volume of fill. Downstream from the impervious section the strippings and some borrowed material were used for the fill, with the most pervious material placed the farthest downstream.

All along the downstream toe a drain trench 10x10 ft. in section was excavated and refilled with rock or gravel to collect possible seepage or the runoff from rain on the downstream face of the dam. This drain connects with a gravel-refilled channel, which extends upstream under the pervious section, although natural drainage is provided by the sand and gravel foundation of this section.

FIG. 3—PLACING EARTHFILL from trucks was followed by bulldozing into 9-in. layers and compacting with sheepsfoot rollers. Typical abutment stripping is shown in the background.

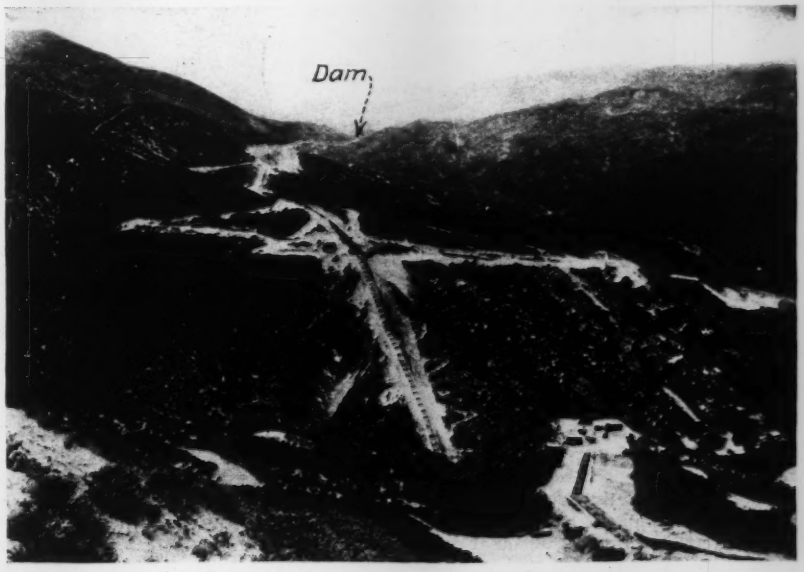


FIG. 4—PIPE-LINE LOCATION from the head of the power-house penstocks looking toward the Bouquet Canyon Reservoir. The first abrupt drop in the line indicates the San Francisquito Canyon.

Impervious fill

An excellent deposit of alluvial sandy clay in the reservoir site about 1 mile from the dam provided the material for the selected impervious fill. This material was mostly of granitic origin and is well graded with the fines passing a 200-mesh sieve running from 25 to 35 per cent. Coarser material grades from sand to 1-in. pebbles. Naturally, there was some variation in the pit, but, with two or more shovels operating, it was possible to make a selection and place the clayey material near the upstream face and the more sandy parts of the deposit downstream.

From three to five weeks ahead of excavation in the borrowpit, the pit was sprinkled to provide the proper amount of moisture content. Loading was done with two 2-yd. electric and one smaller power shovel into 8-yd. trucks. The output from the borrowpit averaged about 19,300 cu.yd. per 16-hour day as measured compacted in the dam. The truck fleet averaged about 35 to 40 units and was rented under contract.

Arriving at the dam, the earth was dumped and spread by bulldozers to an average 9-in. depth of layer. Care was

FIG. 5—ERECTION CARRIAGE, used to handle pipe from end of truck haul, was pulled on wide-gage track by 100-hp. electric hoist, and the pipe sections were supported by two 5-ton air hoists.

exercised to avoid excessive ruts made by trucks; a bulldozer kept levelling off the tracks, and the routing of the trucks was changed frequently. The moisture content of the material arriving at the dam was supplemented if necessary by sprinkling. After compacting the fill, layers were reduced to a 6-in. thickness and the material had a weight of 138 lb. per cu.ft., with an average moisture content of 13 per cent by weight.

Compacting was done by eight units of sheepsfoot rollers of three rolls per unit (Fig. 3). Each unit weighed about 24 000 lb. and required a 65-hp. tractor to pull it. The sheepsfeet were of such a size and so spaced as to exert a pressure of about 200 lb. per sq.in. Not less than sixteen passes were required for compaction. To secure the desired characteristics of roller, most of the units were built by the department.

Technical control of the characteristics of the earthfill as to grading and proper moisture content was an important phase of construction procedure. Studies resulted in the development of important new principles of soil compaction, which were fully described in a series of articles by R. R. Proctor, field and testing engineer, *Engineering News-Record,* Aug. 31, 1933, p. 245; Sept. 7, p. 286; Sept. 21, p. 348; and Sept. 28, p. 372.

After pouring, the concrete cutoff wall at the upstream toe was drilled for a double row of grout holes on 10-ft. centers. Holes 30 ft. deep were put down with jackhammers, and deeper ones (some going down 200 ft.) were sunk with a calyx drill. The cement for the grout contained 10 per cent of bentonite, and 75 lb. of air pressure was used. The small amount of grout taken by the holes indicated that the area below the cutoff was a tight formation.

The concrete facing slab was poured in horizontal strips 42.5 ft. wide running between abutments. This width of strip was determined by the 45-ft. length of reinforcing steel and the design requirement of a 2½-ft. lap. The reinforcing is continuous through construction joints, and no waterstops are provided, as the purpose of the slab is to protect the fill and not to provide watertightness. Reinforcing amounts to about ½ per cent of the cross-section of the concrete slab in both directions.

In addition to the main dam, a smaller earthfill dam was required at a low point in the reservoir site. This dam is 45 ft. high and contains about 136,000 cu.yd. of fill; its characteristics and method of construction were similar to the main dam. Also, a concrete gravity dike was necessary at a small depression. This wall has a gravity section about 11 ft. high and 285 ft. long which will also serve as a secondary and emergency spillway by overtopping.

Inlet-outlet pipe line

A steel pipe line about 3½ miles long (Fig. 4) connects the reservoir with the Owens Valley Aqueduct at a point immediately below the surge chamber of the No. 1 power plant and provides for both filling and withdrawal in accordance with power and water-supply requirements.

At the aqueduct end of the line the line connects with two of the three penstock lines, and at the reservoir end it connects through a 1,060-ft. tunnel to a control tower. The flow in the line is controlled by valves on the penstock end and gates on the tower in the reservoir. The elevation of the lowest gate on the tower is 99 ft. below the water level in the reservoir, which will provide 32,900 acre-ft. of available storage. The capacity of the line is 450 sec.-ft. at low reservoir stage and 700 sec.-ft. when the reservoir is full.

The pipe line is 18,200 ft. long and varies from 80 in. in diameter and 1⅛ in. in thickness of plate at a canyon crossing where the head is 820 ft. to a ⅜-in. thickness and 94-in. diameter at the higher elevations. The pipe is electric-welded throughout, both in the shop and field.

In fabrication the plates were cold-rolled after the edges had been planed to a 30-deg. bevel providing a 60-deg. welding groove on the outside of the pipe sections. After tack-welding, the longitudinal seams were welded by four passes of an automatic machine, with inspection after each pass. After the outside weld was finished the inside of the seam was chipped out to a depth of ¼ in. and a hand bead was placed. Pipes with a thickness of plate from ⅜ to ⅝ in. were made with a bell-and-slip joint connection. These sections are connected in the field by two fillet welds. The sections more than ⅝ in. thick were provided with an 8-in. butt strap of the same thickness as the plate. The straps were welded in half sections to each pipe to facilitate field erection. The ends of these sections were beveled into an interior groove for the circumferential joints, which were welded in the field. Although this interior weld was de-

signed to provide sufficient strength for the joint, two fillet welds were added in the field along the edges of the butt strap.

All sections of pipe $\frac{5}{8}$ in. thick or more were stress-relieved after welding by heating them to 1,225 deg. F. and holding them at this temperature for 1 hour per inch of thickness. Before leaving the fabricating shop each length of pipe was tested to $1\frac{1}{2}$ times the working head.

The pipe was trucked 50 miles to the site from the fabricating plant in Los Angeles. On arrival, the pipe was sand-blasted both inside and out by automatic machine. Next, the inside was given a spray prime coat of asphaltic paint followed by a brushed coat of hot asphaltic enamel applied at 425 deg. F. The outside was sprayed with a coat of red lead, followed by a coat of titanium oxide paint; after placing, it was finished with a final coat of aluminum paint.

Field installation was started at the bottom of the San Francisquito Canyon crossing where the heaviest pipe was required for the 820-ft. head. Following excavation along the pipe-line location, depending on the ground conditions, concrete piers were poured. Ties and stringers were then set for the 9 ft. 10-in. gage track to carry the structural-steel carriage used to set the pipe (Fig. 5). Contrary to usual practice, the track and carriage were built on the center line of the pipe line. On the steep canyons this required the pipe to be delivered at the top of the slopes and lowered to final position.

Pipe sections were moved by truck and trailer from the field yard to the top of the canyon slopes and there transferred to temporary supports. The carriage then moved over the section, and it was picked up by two 5-ton air hoists mounted on the carriage. For the 20-ft. sections of heaviest pipe, which weighed about 9 tons, movable cross-members were used on the carriage for supports during moving and the pipes were lashed securely in position on the steep canyon slopes. The carriage was lowered down the track by a 100-hp. electric hoist, and the pipe was set in position. Along the flatter sections of the line and where the lighter sections of pipe were used, the air hoists were used exclusively to support the pipe.

The project was carried out by the construction organization of the bureau under the general direction of H. A. Van Norman, chief engineer and general manager, bureau of water works and supply; W. W. Hurlbut is engineer of waterworks, C. E. Angilly engineer of design, R. R. Proctor field engineer and in charge of research and tests, Hugh Mulholland superintendent on the dam, J. H. Bouey superintendent on the pipe line. The writer is engineer of major construction.

The consulting board consisted of L. C. Hill, Charles T. Leeds and J. B. Lippincott, all of Los Angeles.

Sewage-Plant Survey—V

Data from Lima, Ohio

THE FOLLOWING ARTICLE is the fifth of a series presenting in brief form the salient design and performance characteristics of American Sewage plants. Articles already published have presented data from the following cities: Decatur, Ill., March 29, 1934, p. 409; Cleveland, Ohio, April 12, 1934, p. 480; Schenectady, N. Y., April 26, 1934, p. 527; Aurora, Ill., May 10, 1934, p. 596.

SEWAGE TREATMENT by the activated-sludge process at Lima, Ohio, achieved 94 per cent purification during the year ending Aug. 31, 1933. The principal design characteristics of the plant and operating data for the latest year of record are given in the accompanying tabulation.

A combined system of sewers is used in Lima. The treatment plant was designed in 1930 by the H. P. Jones Co., to care for a population of 70,000 (predicted for 1950), and to produce an effluent that could be discharged into the Ottawa River during periods of low flow without causing nuisance. Construction was complete and operation was begun in 1932. The total cost of the plant was $561,500, including roadways and a small bridge.

Treatment units include a bar screen, preliminary settling tanks, aeration tanks and final settling tanks. During the year under report the aeration tanks were bypassed during the last half of December, 1932, and the first four months of 1933. After preliminary settling during that period, the sewage was diverted to the final settling tanks. The B.O.D. of the final effluent averaged 9 p.p.m. while the aeration tanks were in use and 106 p.p.m. while they were bypassed. Similarly, the suspended solids average 14 and 58 p.p.m., respectively.

Flows reported in the accompanying tables were measured by a 30-in. venturi meter situated between the primary settling tank and the aeration tank. That portion of the storm flow that is bypassed to the Ottawa River after preliminary settling is not included in the record. Relatively, this is a small amount.

The data for this article have been made available by Walter S. O'Brien, superintendent in charge of the plant.

SEWAGE-PLANT PERFORMANCE DATA, LIMA, OHIO

GENERAL DATA

Population, 1930	42,287
Population served, 1933	38,000
Rated capacity of plant, m.g.d., dry weather	7.0
Sewage flow	
Average m.g.d.	5.5
Maximum day, m.g.d.	7.0

SEWAGE-TREATMENT UNITS

Coarse Screens	
Number of units	1
Width of opening, in.	$\frac{3}{4}$
Method of cleaning	Mechanical rake
Grit Chambers	
Number of units	1
Plan dimensions, each unit, ft.	20x20
Operating depth, including grit space, ft.	2
Depth allotted to grit space, ft.	0.25
Method of cleaning	Revolving scrapers
Frequency of cleaning	Continuous
Primary Sedimentation Tanks	
Number of units	2
Plan dimensions, each unit, ft.	55x55
Operating depth, including sludge space, ft.	10.5
Depth allotted to sludge space, ft.	1.5
Provisions for sludge removal	Revolving scrapers
Frequency of operation	Continuous
Sewage flow, each unit, m.g.d.	5.5
Detention periods at actual flow, both units, hr.	2
Aeration Tanks	
Type	Diffused air, spiral flow
Number of units	4
Length of travel, each unit, ft.	379
Width each unit, ft.	30
Depth of sewage, each unit, ft.	9.5
Type of air diffusers	Porous plate
Total area of air diffusers, sq.ft.	2,016
Sewage flow, all units, m.g.d.	6.0
Return sludge, all units, per cent	17
Mixed liquor	
Volume settled in 1 hr., c.c. per liter	15–20
Suspended solids, p.p.m.	3,000–4,000
Air used, cu.ft. per gal. sewage	1.37
Detention periods (based on sewage plus return sludge), hr.	6.8
Secondary Sedimentation Tanks	
Number of units	2
Plan dimensions, each unit, ft.	70x70
Operating depth, including sludge space, ft.	9.87
Depth allotted to sludge space, ft.	1.0
Provisions for sludge removal	Rotating scrapers
Sewage, flow, all units, m.g.d.	5.5
Detention period at actual flow, all units, hr.	2.9

SLUDGE DISPOSAL

Sludge Digestion Tanks	
Number of units	2
Diameter, each unit, ft.	85
Depth, each unit, ft.	22
Capacity, each unit, cu.ft.	125,000
Temperature maintained, deg. F.	85
Sludge-Drying Beds	
Number of units	10
Length each unit, ft.	173.7
Width each unit, ft.	20
Depth of sand, in.	6
Depth of sludge applied, in.	8–12
Thickness of dried cake, in.	3

ANALYTICAL RESULTS

	Suspended Solids, p.p.m.	Total Solids, p.p.m.	Five-Day B.O.D., p.p.m.
Raw sewage	180	969	149
Primary settling-tank effluent	91.8	864	113
Secondary settling-tank effluent (without aeration)	58	789	106
Secondary settling-tank effluent (with aeration)	14	....	9

SCREENINGS, GRIT AND SLUDGE

	Volume, Cu.Ft. Per M.G.	Dry Solids Per Cent	Volatile Solids Per Cent	pH	Disposal
Screenings	1	.....	.....	...	Incineration
Grit	1.16	84	6.5	...	Fill
Settling-tank sludge	24.5	4.5–7.0	60–65	6.9	To digestion tanks
Excess activated sludge	43.3	2	68–70	...	To digestion tanks
Digested sludge	3.0	5.5–8.0	55	7.6	Sludge-drying beds
Dried sludge	1	60	38	...	Fill

Letters to the Editor

Aerodynamics and the Civil Engineer

Sir—The article by Mr. Pagon entitled "What Aerodynamics Can Teach the Civil Engineer" (*ENR*, March 15, 1934, p. 348) should prove valuable to the profession. Modern research in aerodynamics offers solutions to many of the civil engineer's problems.

Aerodynamics and hydrodynamics are closely related and often identical in their fundamentals. Some authors choose not to separate these branches and speak instead of *fluid mechanics*.

One of the most valuable tools to the research engineer in both aerodynamics and hydraulics is Reynolds' number, which was discussed by the author. Reynolds' number has a sound rational basis. It is used chiefly to classify the two types of flow, laminar or viscous and turbulent. Several practical problems in the study of viscous flow have been solved. Poisseuille's law, concerning viscous flow in pipes, is a rational basis from which the more popular Darcy's law can be derived. Darcy's law is convenient in studying groundwater movements and saturation slopes in earth dams. Stokes' law is a rational solution to the velocity of spheres falling in a viscous medium. As mentioned by the author, the theory has been verified by experiment. The law has been widely applied in sedimentation analysis of particle sizes.

Another field of application of interest to the civil engineer is the mechanical analysis of cements and of clays. The latter has been deemed important in the construction of hydraulic-fill dams. The occurrence of laminar flow has been found in a thin layer close to the bounding surface of turbulent flow. An equation for the distribution of velocity in this "boundary layer" has been derived by Blasius. The shearing force represented in the boundary layer is important in aerodynamics. The writer has estimated the horizontal deflection of the nappe over a sharp crested weir due to air drag. Certain reasonable assumptions were necessary, and the estimated deflection was quite small. Such negative proof is valuable to the designing engineer.

The author has cited the ingenious work performed recently by Prandtl and Von Kàrmán in the field of turbulent flow. Their analysis is based upon the same rational attack which has developed the molecular theory of gases in classical thermodynamics. Von Kàrmán has presented an equation for the transverse distribution of velocity in pipes. The writer has reason to believe that there exist other solutions to the same differential equation which, when combined, may represent the vertical-velocity distribution in an open channel of infinite width. Such analysis must take into account the drag effect of the bottom and of the air above. For practical purposes a wide river should show no drag effect from the sides. The modern theory of turbulence also offers means of computing the amount of energy transformed from turbulence to other forms when the velocity distribution is known. It has been suggested that the amount of sediment carried in suspension at any point is a function of this energy change.

Mr. Pagon referred to the Helmholtz-Rayleigh theory. The original work by Helmholtz and Kirchoff is the basis of a mathematical investigation which has assisted greatly in developing the streamlined blunt nose for dirigibles, and other aeronautical shapes. One of the significant applications of this streamlining is the suggestion of a blunt nose for bridge piers, spillway gate piers or any other obstruction in a stream about which it is desired that water should flow smoothly. This same theory is the basis of determining the equations for the water surface of an orifice jet issuing from a sharp-edged slit. By substituting values for the boundary conditions in these equations, the coefficient of contraction has been computed. The theoretical coefficient checks closely with experimental determinations. Lauck has adapted the Helmholtz-Kirchoff equations, to determine the shape of the nappe over a sharp-crested weir. He has secured coordinates of the water surfaces by a series of successive approximations and has obtained a curve very close to the experimental. The writer has attempted to impose the force of gravity on the original parametric equations and, in the attempt, has stumbled across a series, built up from these equations, which can be evaluated to cover a short range without trouble of divergency. The coordinate values from the series describe a curve that closely fits the lower surface of the nappe. Such an equation is of value in determining the shape of a spillway crest near the upstream edge.

Hydrodynamics has offered the solution to many problems grouped under the phenomena of waves. The civil engineer may find himself confronted with the question of tides, the movement of flood waves or the surface waves on the ocean, reservoirs or lakes. Lord Kelvin laid the groundwork of the theory many years ago. Pressure waves in penstocks introduce the problem of waterhammer. Allievi has definitely solved the theory, which has been verified by tests on penstocks. His classical work, which has been translated into English, precludes the need for further study of empirical formulas by engineers who will take the time to comprehend the theory of waterhammer.

The above paragraphs outline only briefly a few problems in which fluid mechanics can assist the civil engineer.

FRANK B. CAMPBELL,
Junior engineer,
U. S. Bureau of Reclamation.
Denver, Colo.,
March 30, 1934.

* * *

Sir—The interesting article by W. Watters Pagon in the March 15 issue prompts the following discussion:

One winter about two decades ago the writer experienced in Kansas City a prevailing wind which continued at a high velocity for a period of about two days. It was not a hurricane in any sense of the word, yet it produced queer destructive effects. In some residences fires were completely smothered, flat roofs were blown from apartment buildings, windows were shattered, and people were lifted vertically from the ground upon passing in the neighborhood of certain structures.

At that time the writer had great difficulty in comprehending phenomena of this character. Even to the present time the designing engineer is prone to adopt a more or less arbitrary horizontal pressure on buildings due to wind force and then proceed to "design the structure for wind stresses." Ordinarily little consideration is given to the actual phenomena produced by the wind currents, a matter which is frequently of more importance than the possible intensity of direct pressure that the wind might produce. In making these statements it is not intended in any way to belittle the recent developments in the analysis of wind stresses to which structures are subjected. However, particularly in the case of small structures, it is desirable that more consideration be given to a visualization of the flow phenomena and resulting pressures produced by winds.

Mr. Pagon points out that much might be learned from the principles of aerodynamics concerning flow phenomena around obstructions. The model laws in the mechanics of similitude for such phenomena have been discussed and are therefore here dispensed with. Suffice it to say that flow studies may be made with one fluid to imitate conditions that might occur in another, provided the proper model laws are followed and the investigations kept within limiting conditions. Thus it is possible to study the flow around an obstruction completely submerged in a stream of water and to predict thereby the occurrences that would obtain for a similar structure subjected to a stream of air. For example, within certain limits, a model of a submarine might be tested in a wind tunnel; reciprocally, a model of a zeppelin might be investigated in a water tunnel. The details of transferring the results from the experiment to the actual conditions involve a knowledge of the properties (viscosity and density) of the

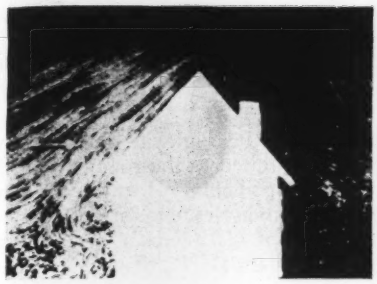


FIG. 1—FLOW CONDITIONS over a house having a steep roof and low chimney. Chimney subjected to "dead air" back-pressure area.

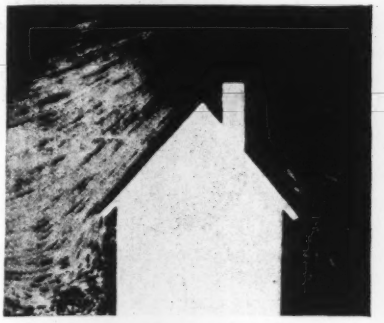


FIG. 2—FLOW CONDITIONS over a house showing suction effect over chimney as a result of the concave streamlines away from the chimney.

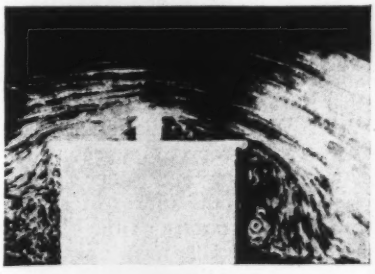


FIG. 3—FLOW CONDITIONS past a flat roof structure. Note streamlines are concave away from roof, indicating suction.

fluids concerned. In some instances the relative compressibility of the fluids is of some importance.

Figs. 1 and 3 indicate the flow conditions around simple structures. The pictures are the result of model experiments made by the Zentrale für Gasverwertung in Germany. The dynamic pressure exerted is a function of the curvature of the streamline; if the curvature is concave away from the object, a "suction effect" results; if concave toward the object, a dynamic pressure greater than the static pressure (the pressure which would be recorded by a barometer in the case of atmospheric conditions) results. Hence by means of experiment some notion of the forces exerted might be obtained simply by observing the nature of the streamlines around the object. This may be done by adding particles or coloring matter to the fluid. A more precise procedure consists in placing piezometer communications at the surface of the model, thus obtaining precise measurements of the variation in pressure.

Although pressure observations are not available for the model shown in Fig. 3, it is evident from the curvature of the streamlines that the pressure on the flat roof would be less than atmospheric, causing a suction upward upon the roof, the curvature of the streamlines being concave away from this surface. Likewise in the case of the sloping roof (Figs. 1 and 2) the curvature of the streamlines would indicate an increase in pressure on the windward side, a decrease below atmospheric on the leeward side. Where the chimney is built to a height above the crest of the roof, the wind apparently is likely to cause improved draft in the chimney; on the other hand, where the chimney is below the crest, there being a "dead air" space practically continuous on the leeward side from the crest of the roof to the foundation, the draft is likely to be poor. These statements correspond to observations made by the Zentrale für Gasverwertung.

Minneapolis, Minn., March 28, 1934. LORENZ G. STRAUB,
Associate Professor of Hydraulics, University of Minnesota.

* * *

Sir—I have read the article in your March 15 issue with considerable interest, for I have always felt that civil engineers could profit greatly from knowledge available to them in contemporary aerodynamics. This was our experience in building the Akron airship dock, where we were able to affect appreciable savings and greater actual strengths by the aerodynamic method as contrasted to the rule-of-thumb method often employed by civil engineers.

The material in the article is presented in a form in which the average engineer can easily understand it. As far as criticism is concerned, we might call your attention to a printer's misarrangement at the foot of column 2, p. 348, where the words *acrodynamics* and *hydrodynamics* have apparently been interchanged. If I am not mistaken, Reynolds' number has been known and used in hydrodynamics since its inception in 1883.

Akron, Ohio, April 5, 1934. KARL ARNSTEIN,
Chief Engineer, Goodyear Zeppelin Corp.

* * *

Sir—In connection with Mr. Pagon's article, I have inquired again and again from engineers of standing in the structural field what is the Reynolds' number, and the reply has invariably been "Never heard of it." Mr. Pagon gives a clearer definition of R than any definition that I have run across elsewhere—namely, a ratio of pressure forces to friction forces.

New York, N. Y., March 23, 1934. ROBINS FLEMING.

* * *

Sir—Mr. Pagon's attempt to arouse an interest among civil engineers in the aerodynamic approach to wind-pressure problems deserves encouragement and support.

In connection with the article itself, it may be stated that within the last few years, we have begun to appreciate that Reynolds' number unfortunately does not tell the whole story, but that another independent variable—turbulence—must be added. An account of our present knowledge of this subject will be given in a paper, "Turbulence, Companion of Reynolds' Number," appearing in the next issue of the *Journal* of the Aeronautical Sciences.

Washington, D. C., April 6, 1934. HUGH L. DRYDEN,
Chief, Aerodynamical Physics Section, U. S. Bureau of Standards.

Salvaging Long Lengths of Cofferdam Sheeting

IN CONSTRUCTING deep piers for a new bridge over the Saguenay River at Chicoutimi, Quebec, steel sheet-pile cofferdams were used, piling 60 ft. long being required to secure the necessary penetration. Also some permanent protection against scour and future dredging was necessary for the piers. This protection could have been obtained by leaving the steel sheeting in place, burning it off at about El. 3.0 and placing a timber strake around it to protect ships from possible damage. But such a method would have been expensive, since the salvaged lengths of piling would have been only 20 ft. in length.

The contractor, A. Janin & Co., Ltd., of Montreal, therefore conceived the idea of splicing 45-ft. with 15-ft. lengths and 47-ft. with 13-ft. lengths by means of steel plates, bolted with the nuts on the side of the pile that would face the interior of the caisson. The concrete of the pier base would then hold the nut while divers removed the bolts on the lower side of each joint, thus salvaging long lengths that could be used over again.

This system left a solid steel belt around each pier, extending 10 ft. below the bottom of its base and alternately 3 and 5 ft. above. Construction progress showed that the system worked well, and the contractor believes that it was also cheaper than a third alternative that had been considered—namely, burning the piles electrically under water at the top of the concrete base, which would have given salvaged lengths of 38 ft. as a maximum dimension.

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Road-Tax Diversion Checked

CONGRESS has put itself on record in the Cartwright Bill as opposed to the diversion of gasoline taxes and motor fees to other than highway purposes. This is heartening news. The fight against the mounting diversion during the past two or three years has been an uphill one. Gas taxes came in so continuously and so easily that state legislature after state legislature has yielded to the temptation to take gas taxes for other than highway purposes until the amount so diverted now amounts to one-third the total collected. To be effective, the fight against diversion had to be carried into every state in the Union. Diversion of state taxes was a state matter, beyond direct federal control. But now Congress has found an indirect way to check the diversion. First, it goes on record as believing that "It is unjust to tax motor-vehicle transportation unless the proceeds of such taxation are applied to the construction, improvement or maintenance of highways." Then, to give concrete form to this view, it provides that after June 30, 1935, "Federal aid for highway construction shall be extended only to these States that use at least the amounts now provided by law for such purposes in each state from state motor-vehicle registration fees, licenses, gasoline taxes and other special taxes on motor-vehicle operators and owners . . . provided that this shall not operate to deprive any state of more than one-third of the amount to which it would be entitled." Thus, in plain language the states are told that Congress opposes diversion of gas taxes from highway purposes and that they have one year in which to eliminate existing diversions that are not clearly within the limits set by state law. Further, by tying the provisions of this act to provisions of existing state laws, states are kept from legalizing existing diversions or from making larger diversions possible by new laws.

Federal Aid for Highways

IN SIGNING THE CARTWRIGHT BILL, President Roosevelt very properly calls the attention of state legislatures to the fact that after July 1, 1935, federal aid for highway work is to go back to the 50-50 basis. The Cartwright Bill makes $200,000,000 available for direct grants to the states during the next fiscal year under the provisions of the Recovery Act of last year, but the $125,000,000 authorized for the two following years is to be distributed under the provisions of the federal-aid highway act of 1916, which requires that the states match federal funds dollar for dollar. Forty-four state legislatures meet next year. If they are to draw upon the national government for their share of federal highway funds, they will have to authorize the expenditure of an equivalent amount of state funds on the highways of the federal-aid system. The bill is a challenge to the state legislatures to set their highway programs in order, to stop gas-tax diversions and to provide other necessary means for taking over part of the burden now carried by the national government. To provide for orderly programming, the act permits the use of a small part of the federal funds for surveys, plans and engineering studies.

Farther Afield

NOT SO MANY YEARS AGO the highway maintainer's principal responsibility was limited to the roadway itself, with a small amount of responsibility for ditches and culverts. His responsibility today extends much farther afield, as shown by the account of Indiana's work in this issue. The situation is comparable to that of railroad maintenance men, for just as these learned that wide shoulders are essential to the stability of the roadbed and to preservation of the ballast, so the highway engineer has learned the importance of shoulders to the life of his pavement and has extended his regular works to include the building and maintaining of shoulders. Likewise clearing of roadsides, once done chiefly to control the spread of weeds, now is recognized as a safety measure.

George W. Fuller

HISTORY will be better able than are we to appraise the contributions of George W. Fuller to the art of water purification, but history will not be so well able to appraise Mr. Fuller's personal qualities of understanding kindliness, sound judgment and tact as are we who have been fortunate enough to have frequent contact with him in our daily work. It is these qualities that first come to mind with the news of his passing, and it is they that should be first recorded in any note of appreciation of his contribution to human progress. Here also should be recorded an acknowledgment of the debt the profession owes to Mr. Fuller, especially his chosen branch of the profession, for his liberal contributions of time and energy to its professional societies. It can be said without fear of contradiction that it was chiefly through his efforts that the American Water Works Association has been raised from the level of a social group to its present high standing as a technical organization. Mr. Fuller's passing also serves to re-emphasize the youthfulness of sanitary engineering and the fundamental nature of the contributions made by a generation of notable men, now largely departed, work that centered around the Lawrence experiments and laid the foundation for present design methods and practices in water filtration. Fuller's work at the Lawrence Experiment Station, following Allen Hazen, was especially notable in that it led to his championing of rapid-sand filtration despite the serious questioning of his older or more conservative associates. These views were brought to fruition in the classic experiments at Louisville, and it was there that the place of mechanical filtration in water purification was first clearly defined. Fuller's achievements and those of others of his generation are a legacy to be utilized by the present generation to carry the art forward to greater perfection.

Dust Nuisance

UNUSUALLY DRY WEATHER in the states of the Middle West has made increasingly voluble the complaints of people who live on unpaved streets. At best the unpaved street problem is a nightmare to the city engineer because appropriations are rarely adequate to oil them or to dust-treat them chemically. In many cities unpaved streets are not even manicured with a blade grader or a simple road drag. In other words the city dweller on an unimproved street is given far less consideration than

those who live on secondary roads in the country. In Detroit, for example, 800 miles of streets are unpaved. Of these, 300 are paper streets, but along an equal mileage the adjoining lots are fairly well built up. From the occupants of these areas far more than the usual 2,500 complaints have been received this year, but with Detroit's closely cropped budget little relief is in sight. Paving, which must be paid for by owners, is out of the question for ten years, officials say. Dust nuisance, grading, snow removal, sidewalks and lighting of unimproved streets are problems in municipal engineering that need far more attention than they have received. They are significant as indicative of the ultimate effect of uncontrolled land use and of the fact that immediate return rather than community benefit is the compelling force behind most land subdividers. The dust nuisance is but one more factor of the many pointing to the necessity for setting up adequate measures of "necessity and convenience" before subdivision is permitted.

Along the Housing Front

DEVELOPMENTS, both unfortunate and promising, occurred along the housing front in Washington last week. Unfortunate, although perhaps inevitable, was the decease of the housing division of the PWA, which has attempted valiantly to spur low-cost housing by limited-dividend companies. Local prejudice, real estate and financial opposition, political bickerings—in short, inherent conditions and entrenched opponents could not be overcome with sufficient speed for any real measure of success to be attained. These factors are specifically mentioned as the stumbling blocks, for it does not seem possible that better-qualified personnel could have been obtained to administer the job.

And this brings up a second unfortunate occurrence—the resignation of Robert D. Kohn as head of the housing division and the clumsy way in which the incident was handled by the PWA. Although it was stated that no question of personal honesty or administrative integrity was involved, the announcement of Mr. Kohn's resignation was made as incidental to the news that an investigation was being conducted into the efficiency and methods of administration of the division. Few persons in the country have a better vision of the true path to housing reform or enjoy a higher reputation for honesty or administrative ability than Mr. Kohn. The PWA could have reflected greater credit on itself and done Mr. Kohn the justice he deserved if it had pointed out that lack of success of the division was inherent in its set-up and not a result of any lack of administrative acumen.

The promising development was the passage of the Housing Bill by Congress in a form acceptable to the Administration. Its acceptability is important to the end that the enthusiasm and optimism that the Administration has evidenced toward this measure should not be diminished. Initiative from the top will be necessary to make the Housing Bill effective, for it has been opposed by some of the same groups that rendered the limited-dividend corporations ineffective. On the other hand, it offers advantages to lender as well as to borrower, and if financing institutions embrace its possibilities, the hoped-for stimulation of the durable-goods industries may become a reality. Passage of the Housing Bill is a constructive development, and with the present tendency to combine all federal housing aids and activities under a single administrator, housing repair and construction may yet provide an important contribution to business recovery.

PWA'S First Anniversary

NOMINALLY, along with the NRA, the PWA was one year old on June 16. As will be seen all too clearly by the diagrams included in the summary of its first year of operation published elsewhere in this issue, the first nine months of its existence were quite ineffective in accomplishing the objective of those who had advocated the passage of the public-works section of the Recovery Act—namely, revival of normal public-works construction in towns, cities and states. Although the entire three-billion-dollar fund had been allocated to specific federal and non-federal projects by the end of January, only an insignificant amount of actual cash had been paid out for non-federal projects. Had it not been for the federal-aid highway work and for the money taken for the CCC and the CWA, the amount of employment provided would have been negligible. In part, this condition is due to the fact that actually the PWA is scarcely ten months old because of the weeks lost last summer in getting the national and state agencies organized.

Those who had high hopes of stimulating general recovery through the quick revival of public-works construction were bitterly disappointed by this development. They had expected that the major part of the PWA fund would be turned into the channels of trade in much the same manner and with the same dispatch that the CWA funds were distributed last winter. But those who were assigned the prodigious task of distributing the fund were so fearful that scandalous waste might develop under any decentralized control system that they set up a system of centralized control at Washington. The establishment of this system plus a long initial delay in setting up the permanent PWA organization in Washington and a further delay in the appointment of state engineers made it impractical for states and cities to submit applications for loans until late summer, and all hope of getting any considerable amount of work under way last year had to be abandoned. In fairness to those charged with the administration of the public-works fund, it must be said that the task is a stupendous one. If they have erred, it has been because of a sincere effort to see that no part of the fund was squandered, or spent unwisely.

The outcome of the slowing up of the PWA was the establishment of the CWA to create the employment that it had been hoped would have been created under the PWA by early winter; and as a necessary corollary to the decentralized CWA operations went complete abandonment of the elaborate PWA centralized control system in so far as the $400,000,000 used for the CWA was concerned.

That is the dark side of the picture. Since the first of the year progress has been much more encouraging, and during the past three months the curve of expenditures on public works of a character contemplated in the Recovery Act has been rising steadily. The money that will be spent this year and next cannot be sufficient to be a determining factor in business recovery under the slow and involved system that has been established, even though supplemented by the maximum amount possible under the Deficiency Bill. But it will be an important contribution to the maintenance of the upturn in business that has begun. It will be an especially valuable contribution if the PWA will concentrate on the small municipal projects now in its portfolio awaiting the allocation of more funds rather than on large projects which will spread expenditures over many months.

CURRENT NEWS

Federal Housing Act Passed by Congress Despite Opposition

DESPITE strong opposition that developed in Congress against the National Housing Bill (*ENR*, May 17, p. 676) the bill was passed during the closing hours of Congress on June 18 and is now before the President for approval. His approval is expected as the bill as passed is believed to contain substantially the provision recommended by the President in his message of May 14 to Congress on housing (*ENR*, May 17, p. 647).

Under the National Housing Bill the Federal Housing Administration is set up with Harry Hopkins already tentatively named as administrator and Corrington Gill, economist of the FERA, as deputy.

To stimulate home renovation the law creates a fund of $200,000,000 to insure loans up to 20 per cent of the aggregate made by any bank, trust company, building and loan association or other financial institution. After this modernization program gets under way emphasis will shift to stimulating new home building. In that field the act provides for insured mortgages up to 80 per cent of the assessed valuation, with an upper limit of $16,000, the mortgage to be amortized in 20 years. The aggregate amount of these mortgages may be $1,000,000,000, including low-cost housing.

One billion dollars also has been earmarked for insuring home mortgages in order to reduce the cost of financing. Interest rates generally will be 5 per cent but may be 6 per cent under certain circumstances.

Deposits in building and loan associations will be guaranteed up to $5,000, as bank deposits now are guaranteed. The Home Owners Loan Corporation capital is increased from two to three billion for refinancing distressed homes and the corporation may lend up to $300,000,000 for repairs to such property.

Kohn resigns housing post

Investigation of the activities of the housing division of PWA culminated last week in the resignation of Robert D. Kohn, New York architect, as director. Mr. Kohn's resignation had not been accepted by Administrator Ickes on June 18, but Col. Horatio B. Hackett, executive in charge of the Public Works Emergency Housing Corp., has been assigned to take direction of Mr. Kohn's unit. It is reported in Washington that the housing division will be consolidated with the Emergency Housing Corp.

Administrator Ickes' dissatisfaction with the handling by the housing division of limited-dividend projects dates back to approval of the Boulevard Gardens project, Queens, involving a land valuation regarded by him as excessive. A check of other projects involving allotments of $20,000,000 followed. Several allotments previously had

(Continued on p. 823)

Activated Sludge, Inc., Sues Equipment Firms

Activated Sludge, Inc., patent licensee in America of the activated sludge process of sewage treatment has filed suit in federal court against twelve firms and individuals who have made parts for the Milwaukee sewage plant or are making parts for the extensions of the plant now under construction. The company asked the court for injunctions against the defendants and for the appointment of a master to assess profits. A decision of the federal district court in Milwaukee holding that the patent was valid and had been infringed by the city was recently upheld by the federal court of appeals. Those named as defendants in the new court action are: G. R. Fehr, Inc., the Chain Belt Co., the Allis-Chalmers Manufacturing Co., the Hunzinger Construction Co., the A. G. Kuetzkow, Inc., the Cream City Boiler Co., the Staff Electric Co., the Hoffman Combustion Engineering Co., the Simplex Valve & Meter Co., the Norton Co., the Carborundum Co. and Roland Becker.

Validity of Missouri Bond Act Tested by Hannibal Suit

A suit to test the validity of an issue of $386,000 toll bridge revenue bonds authorized by the Hannibal, Mo., city council to help finance a proposed automobile bridge across the Mississippi River has been filed in the Missouri Supreme Court at Jefferson City by the city to test the constitutionality of the special act of the Missouri legislature under which it is planned to float the bonds. The court action is in the form of mandamus proceedings to compel State Auditor Forrest Smith to register the bonds. The bridge is being designed by Sverdrup & Parcel, St. Louis, and according to preliminary estimates would cost about $725,488. The Missouri State Highway Department has indicated it will contribute not to exceed $200,000. The PWA has allotted a grant and loan of $526,000 to the city on this bridge, and probably will be asked to accept $386,000 in bonds as collateral for the loan, the balance of $140,000 being an outright grant of federal funds.

Court Upholds Constitutionality of Allegheny County Authority Act

THE PENNSYLVANIA Supreme Court, by a vote of 5 to 2, on June 13, upheld the constitutionality of the Allegheny County Authority Act. The decision paved the way for a $30,000,000 PWA loan and grant for a series of public works projects in Allegheny County. The supreme court decision was on a test case which had been filed on advice of federal authorities after the members of the authority board had been appointed. The constitutionality of the act providing for the creation of the authority, and authorizing it to make agreements with the federal government, was attacked in a taxpayer's suit.

The act in question creates the Allegheny County Authority and authorize it to contract with the federal government for the financing of a number of public improvement projects.

These projects include:

1. Pittsburgh-Homestead high level bridge, a highway bridge across the Monongahela River to replace the existing Brown's Bridge;

2. Highland Park Bridge, a highway bridge over the Allegheny River, replacing an existing bridge;

3. Fort Duquesne Bridge and Tunnel, consisting of a highway bridge over the Monongahela River, and a highway tunnel through Mount Washington;

4. River front improvements along the Allegheny River and along the Monongahela River, including parking facilities;

5. Liberty Tube Plaza at the south end of the existing Liberty Tubes;

6. Glenwood Bridge, a highway bridge over the Monongahela River, replacing an existing bridge;

7. Dravosburg Bridge, a highway bridge over the Monongahela River, replacing the existing Dravosburg Bridge;

8. Jerome St. Bridge and approaches, a highway bridge over the Youghiogheny River in the city of McKeesport, replacing two existing bridges;

9. Rankin Bridge, a highway bridge over the Monongahela, replacing an existing bridge;

10. Banksville Road, consisting of a thoroughfare from the south portal of the Fort Duquesne Tunnel, 14,600 ft. long;

11. Sawmill Run Boulevard, consisting of a thoroughfare from the south portal of the Fort Duquesne Tunnel proceeding westward;

12. Jerome Street improvement, consisting of a wider and improved thoroughfare about 6,600 ft. long through the city of McKeesport.

All but the last three projects listed will be revenue producing.

An agreement between the Allegheny County Authority, the cities of Pittsburgh and McKeesport and Allegheny County provides that existing properties necessary for the construction and operation of the system of improvement shall be transferred to the authority without cost. Allegheny County is to pay all costs of operation, repair and maintenance of the system other than the cost of supervision and collection of tolls and the overhead cost of the authority.

A toll system is to be set up that will pay the interest and principal on the bonds and to pay the administrative expenses of the authority.

Road Tax Diversion Opposed in Bill Passed by Congress

DIVERSION of gasoline taxes and motor fees to other than highway purposes is opposed in the Hayden-Cartwright Bill passed by Congress last week and signed by President Roosevelt on June 18. The act states:

"Since it is unfair and unjust to tax motor vehicle transportation unless the proceeds of such taxation are applied to the construction, improvement, or maintenance of highways, after June 30, 1935, federal aid for highway construction shall be extended only to those states that use at least the amounts now provided by law for such purposes in each state from state motor vehicle registration fees, licenses, gasoline taxes, and other special taxes on motor-vehicle owners and operators of all kinds for the construction, improvement and maintenance of highways and administrative expenses in connection therewith, including the retirement of bonds for the payment of which such revenues have been pledged, and for no other purposes, under such regulations as the Secretary of Agriculture shall promulgate from time to time: Provided, That in no case shall the provisions of this section operate to deprive any state of more than one-third of the amount to which that state would be entitled under any apportionment hereafter made, for the fiscal year for which the apportionment is made."

Return to normal practices

In approving the Hayden-Cartwright Bill President Roosevelt said, in part:

The act provides for a gradual tapering off of emergency highway expenditures and lays the foundation for a return to normal expenditures.

Of the $522,000,000 authorized to be expended by the act, $450,000,000 is allotted for federal participation with the states in highway building, of which sum $200,000,000 will be a federal grant, and the remaining $250,000,000, the federal portion of regular federal aid for the fiscal years 1936 and 1937, to be matched by the states on a 50-50 basis. The balance, $72,000,000, is to be applied at the rate of $24,000,000 annually to highway activities in the national forests, national parks, Indian reservations and the public lands. Including the contributions to be made by the states and the $230,000,000 which will be carried over from the $400,000,000 appropriated by Congress last year, the total sum to be paid out for highway construction during the three-year period will be more than a billion dollars.

The act provides that states, to be eligible for full participation in federal aid, must continue to use for roads at least whatever portion of their revenues from gasoline and other taxes on motor vehicles is now authorized by law to be expended for highway purposes. Notice is also given to the forty-four state legislatures which will convene early next year that unmatched emergency grants are to be abandoned and that there is to be a return to the established plan which requires that the states shall meet the federal government half way in paying the cost of new construction.

It is important to note that the sums mentioned above represent only an authorization by the Congress and *not* an appropriation. Funds for work to be done the first year the act is in effect are contained in the Deficiency Appropriation Bill.

As noted in the President's statement, the bill authorizes the expenditure of $200,000,000 by the federal government in the fiscal year bginning July 1, 1932, under the provisions of the Recovery Act (*i.e.* not to be matched 50-50 by the states), of which not less than 25 per cent of the amount apportioned to any state shall be applied to secondary roads. In each of the two following fiscal years $125,000,000 is to be apportioned to the states on the basis of the Federal-aid Highway Act of 1916, as amended (*i.e.* to be matched by the states on a 50-50 basis).

The Secretary of Agriculture is authorized to fix a smaller percentage of the apportionment to secondary and feeder roads upon a satisfactory showing by the highway department of any state.

Expenditure by the Secretary of Agriculture of $10,000,000 for the repair of damage to highways by floods, hurricanes, earthquakes or landslides is authorized as is expenditure of $10,000,000 for forest roads, $2,500,000 for roads on public lands, $7,500,000 for road administered by the National Park Service, and $4,000,000 for roads through Indian reservations in each of the fiscal years beginning July 1, 1935, and July 1, 1936. Expenditure of $75,000 for surveys, plans and estimates for a proposed inter-American highway is also authorized.

Future planning

The act provides that not more than one and one-half per cent of the money apportioned to the states may be used for surveys, plans and engineering investigations for future projects. It provides also that for the period during which it is in effect the term highway as defined by the Federal Highway Act of 1921 shall include "such main parkways as may be designated by the state and approved by the Secretary of Agriculture as part of the federal-aid highway system."

Bids Called For On Parker Dam

Bids have been called on July 26 by the Bureau of Reclamation for the construction of the Parker Dam, a part of the Colorado River water supply for Los Angeles, Calif. The invitation for bids does not cover the purchase of materials that are to be furnished by the government. The Parker Dam will form the pool from which the Colorado River water will be pumped through the new aqueduct to Los Angeles.

New Subsistence Homesteads Planned for Lake County, Ill.

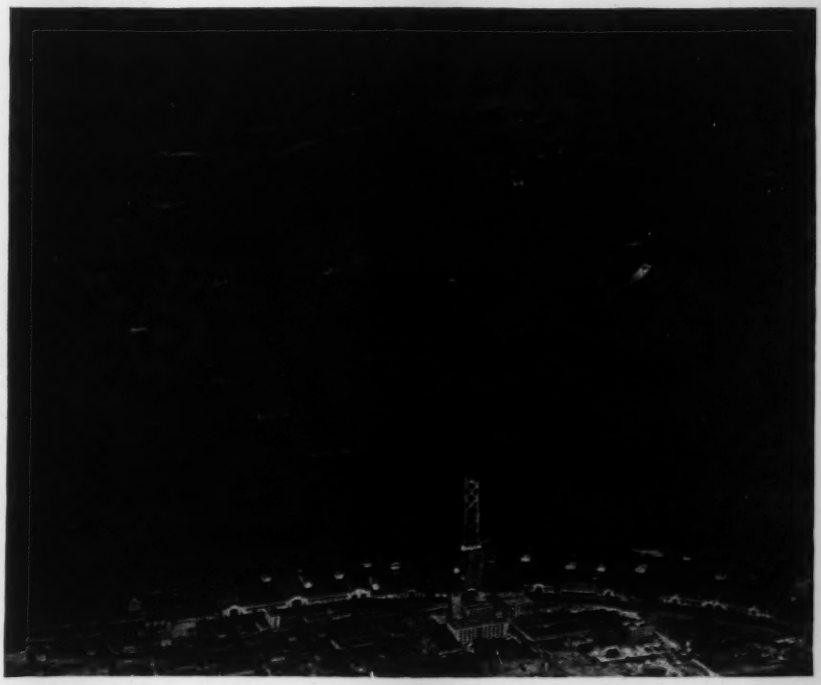
Approval has been given to plans for the establishment of a subsistence homestead project in Lake County, Ill., it has been announced by Secretary of the Interior Ickes. An allocation of $150,000 has been made for this project.

Fifty subsistence homesteads will be included in this project. They vary in size up to 10 acres. They are planned for the benefit of part-time workers in industrial plants located throughout Lake County, including the industrial towns of Waukegan and North Chicago.

No attempts will be made to establish a special community. Seven different tracts are being purchased, on which the 50 homesteads will be established. They are so located that no new community facilities will be necessary. Each homestead will cost about $3,000.

FOUNDATION WORK TRACES THE COURSE OF THE NEW BRIDGE ACROSS SAN FRANCISCO BAY

With work under way on almost every pier of the long bridge being built over San Francisco Bay, the route of the bridge can be traced in this air view, from the westerly tower on the San Francisco shore in the foreground, across Yerba Buena Island and over the East Bay crossing to the Oakland shore. The white streak extending out from the Oakland shore is the sand fill pumped in place to form the east approach. The west tower in the foreground was topped out last week.



Carpenters, Bricklayers and Electricians Rejoin A. F. of L.

As a result of negotiations begun by William Green, President of the American Federation of Labor, the International Brotherhood of Electrical Workers, the United Brotherhood of Carpenters and Joiners and the Bricklayers, Masons and Plasterers International Union have reaffiliated with the building trade department of the American Federation of Labor. This reaffiliation is considered to be an important step toward the avoidance of jurisdictional disputes within the building industry.

Bidding Conditions Discussed at New York Mayors' Conference

Collusive bidding permitted under the NRA and not the price situation is the worst part of the codes for the taxpayers, according to Paul V. Betters, director of the American Municipal Association, whose address was one of the chief features of the New York State Conference of Mayors and City Officials at Jamestown, N. Y., June 14. Mr. Betters said that every time a city calls for bids, identical bids are submitted and city officials are forced to violate state and city laws in awarding contracts. Competitive bidding, he declared, is a farce and the taxpayer foots the bill.

The conference adopted the following resolution, offered by Mayor Wendell E. Phillips, of Port Jervis:

"Whereas, in certain instances it appears that the present regulations of the Federal Emergency Relief Administration regarding rates of pay and hours of work on work relief projects have tended to discourage efforts of persons employed on these projects from seeking normal employment in private enterprises, therefore, be it resolved:

"That the conference of mayors petition the Federal Emergency Relief Administration to so amend the present regulations as to both rates of pay and hours of work as to make possible in any locality a structure which will avoid direct competition between work relief and private commerce and industry, and at the same time provide relief in an amount adequate for the necessaries of life of the worker and his dependents.

"Be it further resolved that the American Municipal Association be asked to cooperate in an effort to achieve this end."

The building codes of New York state cities and villages were attacked by George P. Keogh, of the state department of labor, his criticism being based on analysis of existing codes that had been made under the auspices of the conference, the department of labor and New York University. Mr. Keogh declared, as a result of these findings, that it is not the building codes of the small communities but those of the larger cities that are most defective.

Sixteen municipal codes, Mr. Keogh said, have not been revised in fifteen years. Antiquated requirements have been permitted to remain in new revised and amended codes. In one which was revised four years ago, he said, it is required that a candle or sperm-oil lamp shall be kept burning at each exit and at the head and foot of each stairway. One code provides for the construction of "all roofs of ordinary masonry buildings, comparatively flat or sloping not more than 60 degrees." He said that there is an absence of uniformity of the minimum standards relating to strength of materials and that many specifications of materials lack simple engineering requirements and are not in conformity with common practice.

Local Preference Regulation Rescinded by PWA

Regulations of the PWA regarding local preference in the purchase of materials on federal projects have been rescinded by Administrator Ickes. The regulation has required, where available, the use of materials produced where the job is located.

The rescinding order states: "Except as otherwise provided by law, all future contracts will be awarded solely upon the basis of lowest responsible bidders. Where prices, quality and quantity are the same, applicants may select any of the low bidders or may divide the orders as they desire." On construction contracts already let, the enforcement of the local preference regulation will be optional with the applicant, the rescinding order provides.

New York Code Administration Checks Violation Complaints

The New York State Administrative Agency of the Divisional Code Authority for General Contractors is investigating every complaint and reported violation concerning Chapter II of the construction code. In almost every case, it has been found, the complaint has been based on wrong or incomplete information on the part of the complainant or ignorance on the part of the contractor involved. Whenever a complaint or report of violation is received, the Agency calls all parties concerned into a meeting where all facts are discussed openly. In almost every case the trouble has been settled at the meeting, eliminating the necessity of sending the complaints to Washington. Most of the complaints concern the bidding practices section of the code and the jurisdiction of divisional chapters. In the latter case the complaints are referred to Washington for decision.

The New York agency of the Mason Builders Division, Chapter VIII, maintain that general contractors doing mason work are subject to Chapter VIII provisions and demand that the general contractors doing such work file a copy of their estimates on masonry with the code authority and pay a registration fee. The agency for Chapter II has advised its contractors to refuse to comply with these demands and the case is now in Washington waiting decision.

The New York agency for Chapter II has set up bid depositories for private work in localities throughout the state where requested by a represenative group of general contractors. The administration of subdivisional Chapters II-B and II-C will be handled through the main office in New York City; that of Chapter II-A will be through divisional offices around the state. The agency has completed its organization with the selection of James E. Gibbons as director. Other officers are: James L. Carey, chairman; W. G. Luce, vice-chairman and W. G. Goble, treasurer. Temporary headquarters have been established at 51 Chambers St., New York City.

Construction Code Adjustment Board Holds First Meeting

The National Construction Planning and Adjustment Board, the industrial relations board provided for under the Construction Code, composed of ten employer and ten employee members and an impartial chairman (see *ENR*, June 14, 1934, p. 789), was formally organized at a meeting held at the Willard Hotel in Washington, D. C., on June 14.

At the first regular meeting of the board on June 15, various operating committees were appointed. An executive committee of seven members, composed of three employer and three employee members with the chairman, was appointed to deal with requests for increase in maximum hours under the code on isolated projects, or in communities where sufficient skilled labor is not available, as is provided under paragraph 1 and 2 of Section 2-B of Article III. The board also established a by-laws committee and directed the chairman and secretary to prepare a budget. The entire ten employer members of the board and the chairman were designated to the committee on jurisdictional disputes, to report to the board on ways of eliminating such disputes.

Other committees were appointed to watch the operation of area agreements and recommend suitable provisions for labor compliance necessary when area agreements are effectuated.

Separate home builders code

The board instructed the chairman to protest on behalf of the board against a separate code for Land Development and Home Builders. A public hearing on June 14 on the proposed separate code brought forth a representative gathering of employer and employee interests of the construction industry as well as from the sponsors of the separate code, the Land Development and Home Builders Division of the National Real Estate Boards.

The construction industry protested vigorously the separating from the construction code of street improvements and the construction of one and two family homes which were already included under the construction code, although the sponsors of the separate code were granted on March 21 a stay from operating under the construction code in so far as trade practices were concerned, but not as to labor provisions (see *ENR*, Apr. 12, 1934, page 486).

The proposed separate code has the following definition:

"The development of land as building sites for purposes of sale or lease and the sale or lease thereof, including maintenance prior to or incident to such sale or lease; and the building of one and two-family homes for the purposes of sale or lease and the sale or lease thereof including maintenance, remodeling or repair thereof prior to or incident to such sale or lease."

Farmers' exemption

On June 14 NRA made public an exemption from the Construction Code for those engaged in agricultural pursuits. The exemption applies to "any individual, form of organization or enterprise, engaged in agri-

cultural pursuits on his own or its own behalf while in the performance individually or with members of an individual's family or with his or its regular employees of any activities in the construction of any project to be used as a direct and integral part of farm operations."

A regular employee is defined as meaning "any employee whose regular and normal employment is confined to and is an integral part of such agricultural pursuits, and includes individuals likewise engaged, assisting in any such activities without pay from any such individual, form of organization or enterprise in a cooperative endeavor."

Code authority meeting

The regular meeting of the Construction Code Authority was held in Washington on June 15. Following recommendations of the executive committee, the meeting took definite action to clarify the question of administration and assessments within the respective divisions of the industry, and directed that explanations of the code be issued to cover such subjects. A budget was approved for travel and subsistence expense of the members of the Construction Appeals Board, and the Executive Director was directed to furnish the necessary staff and office facilities needed by the board.

Progress was reported on the establishment of necessary statistical service to be instituted as soon as the financial condition of the Code Authority permits, and when current information is required by NRA and other governmental agencies.

Coordination of divisions

Procedure was instituted for coordinating the actions of the various Divisional Code Authorities in regard to interpretations and explanations of the Construction Code, with those of the Construction Code Authority, to the end that such action by divisional code authorities will be limited to provisions of their respective divisional chapters, and not involve the provisions of Chapter I. Overlapping cases are to be handled by joint action.

The meeting approved a suggestion made by the Executive Committee for freezing duplicate copies of sub-bids in depositories at a time in advance of the submission of the original of such bids to the general contractor. This suggestion was to be sent to all divisions of the Construction Industry by a special committee.

Vacancy on adjustment board

A vacancy having occurred in the employer membership of the National Construction Planning and Adjustment Board, through the non-acceptance by L. J. Horowitz, the Secretary was instructed to notify all members of the Construction Code Authority to make nominations for a building general contractor by July 10, at which time a letter ballot would be sent out to fill the vacancy.

The Authority decided to hold its next meeting in Chicago about the middle of August.

Additional code chapters

On June 8 the Administrator approved, on behalf of the President, Chapter XIV, Insulation Contractors Division, which became effective June 18; and on June 11, he approved Chapter XI, the Kalamein Door Division, which became effective June 19. Accordingly, fourteen chapters have now been provided for.

George W. Fuller Dies; Eminent Sanitary Engineer

George Warren Fuller, consulting sanitary engineer and internationally known expert on water supply and sewerage, died on June 15 after a brief illness at his residence in New York. He was 65 years old. For many years he had been the senior member of Fuller & McClintock, consulting engineers of New York City.

Mr. Fuller was born at Franklin, Mass., and received his formal schooling at the Massachusetts Institute of Technology, from which he graduated in 1890. Directly following his graduation, he studied for about a year at the University of Berlin, and in the office of Piefke, engineer of the Berlin Water Works.

After his return to this country Mr. Fuller devoted about nine years to research work on methods of purifying water and sewage

George Warren Fuller

from the biological, chemical and engineering viewpoint, and it was during these years that he laid the foundation for his later eminence. During this period he first entered the service of the Massachusetts State Department of Health and became one of the group of experts operating the Lawrence Experiment Station, then under the direction of the late Allen Hazen. When Mr. Hazen left Lawrence, Mr. Fuller became bacteriologist in charge. The experiments on water purification at Lawrence, largely in connection with slow sand filtration, laid the groundwork for much of sanitary engineering.

In October, 1895, Mr. Fuller was engaged by the Louisville Water Co. to supervise a series of experiments on the filtration of Ohio River water. It had been made evident to him by early experiments that slow sand filtration was utterly inadequate to cope with Louisville's water, which sometimes ran as high as 5,000 p.p.m. of turbidity. Mechanical or rapid sand filtration had been practiced for about ten years but was then in the hands of commercial companies which had paid little attention to the scientific aspects of water treatment. The Louisville Water Co. decided to test rapid filters on a working scale, but under the immediate direction of the manufacturers of the equipment. Accordingly working scale units were set up and operated by three of the filter companies. During the experimental period, studies were also made of the electrolytic treatment of water and of the Polarite filter.

These experiments and the preparation of his classic report on them occupied Mr. Fuller for a little over two years, from 1895 to 1897. They laid the foundation for rapid filtration as practiced for the past 30 years. Particularly they demonstrated the major part that was to be played in the case of highly turbid water by sedimentation and coagulation.

For some reason, Mr. Fuller was not given a hand in the work of designing the Louisville filters following the close of the experimentation. It was not until early in 1908 that these new filters were ready for operation. It was then found that they were so defective in design as to make shutdowns and reconstruction imperative and Rudolph Hering and George Fuller were engaged as consulting engineers. On their recommendation the strainer system was rebuilt and the coagulation basin enlarged.

Associated with Mr. Fuller on the Louisville experiments were a number of men who subsequently made names for themselves in the field of sanitation. These included Robert Spurr Weston, Joseph W. Ellms and the late George A. Johnson, for the water company, and George A. Soper for one of the filter companies.

From Louisville Mr. Fuller went to Cincinnati and there conducted experiments on water filtration in 1897 and 1898. A little later he was a member of an advisory board on a new water supply for New Orleans and as such gave particular attention to the water treatment experiments conducted there under the immediate direction of Robert Spurr Weston.

After a period of experimental studies of water treatment at Lawrence, Louisville and elsewhere, the knowledge he had there gained was put to practical use by Mr. Fuller in the design of the Little Falls filtration plant of the East Jersey Water Co., put in use in 1902. There the small circular filter tanks of the old filter companies gave way to the larger rectangular concrete filter tanks that have since been standard and which have been adopted by hundreds of American and Canadian cities.

During his professional career Mr. Fuller served as consulting engineer for major waterworks and sewerage improvements in more than 150 large cities in this country and abroad. One of his most important assignments was his engagement by the Sanitary District of Chicago in 1924 as chairman of a board of 28 experts to study the effect of the diversion of water from Lake Michigan into the Mississippi River as a sewage disposal measure.

In addition to his strictly technical activities, Mr. Fuller was very generous of his time in professional affairs. One of the greatest services he rendered was his work as chairman of the Standardization Council of the American Water Works Association, extending from 1920 to 1927, and resulting in the volume entitled "Manual of American Water Works Practice" published in 1925. In his masterful way, Mr. Fuller directed, harmonized and spurred on the work of numerous committees and subcommittees engaged in its preparation.

Mr. Fuller was a past-president of the American Water Works Association, the American Public Health Association, and a past-vice-president of the American Society of Civil Engineers. He was elected chairman of the Engineering Foundation in 1933, and held that office at the time of his death.

Contractor Sues for Damages from Alleged Faulty Plans

W. I. Bishop, Ltd., contractor of Montreal, has instituted in the Hull, Quebec, Superior Court an action to recover $375,000 as damages from the James MacLaren Co., Ltd., of Buckingham, Que., alleging errors in plans and specifications submitted for the receiving of tenders on the construction of the High Falls Power project resulted in the plaintiff tendering a lower amount than it would otherwise have done. The High Falls dam and power house was built on the Lievre River, Quebec, by the plaintiff between October, 1928, and August, 1930. The cost of the project was $2,045,611.

Housing Projects Rejected Because of Lack of Funds

Two privately sponsored housing projects in New York City had their applications for PWA funds rejected by Secretary Ickes on June 12. They were $45,500,000 Rutgerstown project on the lower East Side, and the Queenstown project at Flushing, Queens, estimated to cost $46,856,300. The sponsors were told by the Public Works Administrator that he had found it "necessary to disapprove both applications, largely because there are no funds available for private housing projects."

It was pointed out that the PWA has discontinued loans to semi-private corporations for housing, and has turned over all such financing to the Federal Emergency Housing Corp., recently established.

Funds for Public Work, Roads and Relief in Deficiency Bill

The Deficiency Bill, as finally passed, carries $899,675,000 for direct relief, public works, roads, and other items. The limit of $500,000,000 on public works expenditures is exclusive of the proceeds from the sale by the PWA to the RFC of bonds acquired in financing non-federal projects, but only $250,000,000 may be expended by the RFC for this purpose. There was no such restriction in the bill as originally introduced.

The bill specifically provides that the $100,000,000 apportioned for roads shall be part of and not in addition to $200,000,000 carried by the Cartwright bill. The law carries $525,000,000 for drought relief but limits its availability to one year.

In allocating the $500,000,000 fund for public works Mr. Ickes said Tuesday that preference will be given to non-federal projects over federal projects and to applications asking grants only, as he regards municipal credit on the mend.

Any possibility of early approval of $172,000,000 for the Central Valley Power and Conservation Project in California, was eliminated when Mr. Ickes said that such a huge development could not be considered seriously.

PWA Estimates That Non-Federal Projects Will Repay 80 per cent of Financing

ABOUT 80 per cent of the financing provided by the PWA for non-federal projects is represented by loans to be repaid to the government, according to a preliminary estimate made by Administrator Ickes. Of the $773,625,000 of PWA loans-and-grants for non-federal projects, used in making this estimate, $614,000,000 will be repaid, leaving a balance of $159,625,000 which would be the government's obligation on grants of 30 per cent of the cost of the 2,338 projects which will be constructed by states, counties, municipalities, and other public bodies. The Administrator considers these figures as tentative, but considers it to be the best forecast available at the present time to indicate the cost of non-federal public works construction to the federal government.

The present tendency for many cities to change from loan-and-grants to straight grants will have a tendency to change the percentage indicated by the present estimate. Almost 200 allotments have already been changed to grants of 30 per cent, as municipalities are able to dispose of their bonds in the private market.

Allotments for grants have been made for 1,105 non-federal projects totaling $45,715,000. Loan-and-grant allotments totaling $455,897,000 have been made to local bodies for carrying forward construction of 1,233 non-federal projects.

The recipients of these loan-and-grant allotments will receive the 30 per cent allowance as a direct gift from the federal government but the total obligation of the PWA will be less than 30 per cent of the total $455,897,000 allocation because the total cost for many of these projects includes purchase of land and the paying of legal and engineering fees which cannot be included in the PWA 30 per cent grant.

Considering these factors, it is estimated that the federal government's contribution by way of grants on the $455,897,000 of loan-and-grant allotments will be less than 25 per cent and the balance of $341,987,000 will be secured by loans to be repaid with interest at 4 per cent.

Allotments of loans only, without grants, totaling $272,013,000, have been made for creating construction work to be done by railroads, toll bridge companies, and public corporations organized to construct low-cost housing. All of these loans are secured by mortgages or collateral securities.

These figures of federal government participation in non-federal public works projects are summarized in the following table:

Estimated amount to be repaid:		
Loans only without grants	$272,013,000	
Loan of loan-and-grant allotments	341,987,000	$614,000,000
Estimated 30-per cent contribution:		
Grants only without loans	45,715,000	
Grant of loan-and-grant allotments	113,910,000	159,625,000
Total non-federal allotments		$773,625,000

White House Addition Approved by President

President Roosevelt has approved plans for a $325,000 addition to the White House offices. Work on the new wing which will extend eastward from the present offices is expected to start soon and will require about four months. It will provide a new presidential office similar in design to the existing one.

Improvement of Streams Protested by Fishermen

That CWA and FERA projects have damaged fields and streams, thereby damaging the wild life of the state, is charged by B. J. Hill, president of the Ohio Izaak Walton League, and David S. Warner, secretary of the Ohio Water Conservation Board. The charge is that workers have taken crooked places out of streams, eliminating all natural resistances to the flow of water and destroyed deep places where fish live. They deplored the cutting of the underbrush which destroys game refuges.

Moffat Tunnel-Dotsero Cutoff Opened to Rail Traffic

The long-thwarted plans of David H. Moffat, pioneer railroad builder of Colorado, for a direct rail route from Denver to Salt Lake City to place Denver on a transcontinental route, were realized on June 16 with the start of train operation over the Dotsero cutoff connecting the Denver & Salt Lake (Moffat) R.R. and the Denver & Rio Grande Western in western Colorado. At the beginning of the century Moffat started work on his line to run due west from Denver, planned to cross the Continental Divide through a tunnel under James Peak. He was beset with financial difficulties which prevented driving of the tunnel at that time. Instead, a steep and tortuous route was built over Rollins Pass, crossing the divide at an elevation of 11,600 ft. Lack of funds stopped work on the new line when the rails had reached Craig, Colo., only 232 miles from Denver and less than half of the distance to Salt Lake. Craig, in the middle of the barren Yampa River valley, is the present western terminal of the line. Moffat died penniless in 1911, still trying to raise funds for the completion of the route through to Salt Lake.

In February, 1928, the 6.2-mile Moffat tunnel was completed under James Peak, eliminating 23 miles of track over Rollins Pass and a 2,600-ft. climb. Estimated to cost $6,000,000, the tunnel was finally completed at a cost of $18,000,000, the extra expense being due to unprecedented construction difficulties. The tunnel was financed by the sale of improvement district bonds and now is leased to the Moffat railroad.

Two years ago the D.&R.G.W. acquired financial control of the Moffat railroad and laid plans to connect the two lines by a 38-mile cutoff between Orestod on the Moffat line and Dotsero on the Rio Grande, following the Colorado River. A loan of $3,850,000 by the RFC enabled the work to be undertaken. The construction contract was held by a combination of Utah Construction Co., Morrison-Knudsen and W. A. Bechtel.

The D.&R.G. route from Denver to Salt Lake, via Pueblo and Royal Gorge, is 745 miles long. By operating over the Moffat, through the tunnel and over the cutoff, this distance is cut by 175 miles, or about eight hours' running time for passenger trains. The Denver-Salt Lake distance over the new route is 540 miles, as compared with 578 miles on Moffat's planned line via Craig, and 614 miles on the Union Pacific.

Transcontinental passenger service over the new route from Chicago to the Coast will be effected by both the Burlington and Rock Island railroads, which will turn through cars over to the Rio Grande at Denver. From Salt Lake westward the Burlington's cars will operate over the Western Pacific, and those of the Rock Island over the Southern Pacific.

Housing Bill Passed Despite Opposition

(Continued from p. 818)

been rescinded and the ear-marked money turned over to the Emergency Housing Corp. to undertake low-cost housing projects directly. Reappraisement of land valuation at Boulevard Gardens has resulted in a reduction from $863,440 to $550,440. The reappraisement was made by a neutral committee headed by Henry Bruere, president, Bowery Savings Bank, and followed the execution of the loan contract with the limited-dividend corporation. Mr. Ickes declared that land value is the key to low-cost housing.

"There is no question of dishonesty but one of very loose business methods," said Administrator Ickes, in commenting on Mr. Kohn's resignation. He added that there was "too much of a tendency to take estimates of borrowers rather than checking these estimates through outside interests."

For some time past it has been apparent that PWA's major drive for low-cost housing would be made through the Emergency Housing Corporation. Little information on the extent of its operations has been disclosed because of the activity of real estate speculators in localities where it is believed that the federal corporation desires to assemble tracts. Two projects now are under way in Atlanta, Ga., and PWA announced this week that the Dept. of Justice had filed condemnation proceedings to acquire 17 acres for the Cedar-Central project in Cleveland, Ohio, to cost $2,870,000. Options had been secured on 70 per cent of the site, but court action was deemed advisable to get clear title.

The Cedar-Central project was brought forward originally by Cleveland Homes, Inc. After careful study it was transferred from the PWA housing division, which handled all applications of limited-dividend corporations for loans, to the housing corporation. It now has been decided that the government through the housing corporation will do the work.

The Cedar-Central site is only 1.5 miles east of the Public Square. It is one of the seven areas in Cleveland declared by local officials as "blighted" and is part of a metropolitan long-range plan for rehabilitation. The proposed improvements will consist of three-story apartment buildings, divided into two, three, four and five-room apartments to accommodate about 800 families, or roughly about 3,000 persons. Buildings will cover only 25 per cent of the ground area.

Two Bids Received On Grand Coulee Dam

Two acceptable bids were received for the construction of the Grand Coulee Dam on the Columbia River in central Washington, one from Silas H. Mason, Inc., New York, for $29,339,301 and one from Six Companies of Washington, Inc., for $34,555,582.

Three other contracting companies were affiliated with the Mason company in submitting the low bid. They were the Walsh Construction Co., of Davenport, Iowa, the Guy F. Atkinson Co., of San Francisco, and the Kier Construction Co., of San Diego.

Six Companies of Washington, Inc., is an affiliate of Six Companies, Inc., builder of the Boulder Dam.

Brief News

TEST WELLS are being sunk in the Steelton area of Sault Ste. Marie, Ontario, in an effort to locate a well supply to furnish the entire city water requirements. At present the city is furnished by an artesian well at Steelton and from the waters of St. Marys River.

A LAW HAS BEEN ENACTED by the New York State legislature authorizing the Board of Supervisors of any county to create a county water authority. The authority is to be created by resolution and approval of the water power and control commission of the state. The authority would be given power to acquire, own, construct and operate a municipal water system, and to issue its own bonds.

THE LONG DISCUSSED plans for extensive development of the Hackensack Meadows, a tide-swept area adjacent to Newark, N. J., has been revived by Mayor Ellenstein of Newark. He proposes a commission with proper powers to float bond issues that would not increase the city debt, but which could be amortized in time through proceeds of the developments they carry out. The mayor believes such an authority could attract large industries to the meadow lands.

THE STATE OF CALIFORNIA has announced three important filings on Sacramento and American River waters to prevent any efforts of private interests to make diversions from these streams in interference with the state-wide water plan. State officials announce the intention of taking enough water for the state to protect the needs of the Central Valleys water project and the coordinated water plan. Filings will be made on other streams essential to the state-wide plan.

FOUR YEARS AGO the state highway department of Illinois proposed a hard-surfaced road from Hamilton to Nauvoo to follow along the winding banks of the Mississippi River. The shortest route between the towns was deliberately ignored in favor of the more scenic route along the river. But some 40 residents of Hancock County wanted a road solely for "convenience and necessity" and filed a petition seeking a permanent injunction to restrain the state from completing the road according to plan. After a change of venue, the court recently ruled that the state has the right to build a road for scenic beauty as well as for serviceability and denied the injunction.

SOCIETY CALENDAR

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting at Cornell University, Ithaca, N. Y.; regular meetings June 21-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Vancouver, B. C., Canada, July 11-14.

INTERNATIONAL CITY MANAGERS ASSOCIATION, annual conference, St. Louis, Oct. 15-17.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, Annual Meeting, Rochester, N. Y., September 24-28.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Annual Meeting, Rochester, N. Y., September 24-28.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, held its spring meeting at Jamestown, N. Y., on June 14. Henry Ryon of the New York State Department of Health presented a paper on the treatment works at the Garlem Valley state hospital at Wingdale. J. H. Brendlen spoke on "Present Aspects of Chemical Treatment of Sewage and Sludge." Other speakers on the program were A. E. Stilson, William Raisch, W. H. Pitkin, A. F. Allen, C. E. Keefer, William G. Taylor, C. C. Agar and E. B. Besselievre. It was decided to hold the fall meeting in Oneonta in October.

WESTERN PROFESSIONAL MEETING of the ENGINEERING INSTITUTE OF CANADA will be held in Vancouver, B. C., July 9-13, in conjunction with the summer convention of the American Society of Civil Engineers.

LOUISIANA SECTION, American Society of Civil Engineers, at its annual meeting elected John H. O'Neill president. The section voted to continue the award of scholarships to students of Tulane University and Louisiana State University.

PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION, Seventh Annual Conference, State College, Pa., June 25-27.

PENNSYLVANIA SEWAGE WORKS ASSOCIATION, Eighth Annual Conference, State College, Pa., June 27-29.

Personals

M. O. SYLLIAASEN, city engineer of Seattle, has resigned his post, and O. A. Piper, chief assistant, will hold the place until a new city engineer is appointed.

C. A. Betts, formerly office engineer, Bureau of Reclamation on the Owyhee dam and previously in a similar position on the Moffat tunnel project is now on the technical staff of the Mississippi Valley Committee in Washington.

T. B. PARKER, formerly of the hydraulic engineering department of the Stone & Webster Engineering Corporation, Boston, Mass., has been appointed engineer for the PWA in Massachusetts, succeeding Col. Charles R. Gow, resigned.

CHARLES H. FOSDICK has been promoted from deputy superintendent of highways of Erie County, N. Y., to superintendent, to succeed George C. Diehl, who will retire on July 1. The appointment is subject to the confirmation of the State Civil Service Commission.

O. S. ROEN, city manager of South Pasadena, Calif., since Oct. 1, 1927, has been appointed city manager of Alhambra, Calif., effective July 1. South Pasadena and Alhambra are adjoining communities. He will be Alhambra's eighth city manager, succeeding L. D. White, resigned. Mr. Roen previously served for seven years as city manager of Ontario, Calif.

F. G. CHRISTIAN, civilian engineer, War Department, has been transferred from

Vicksburg, Miss., where he was assistant chief of the general engineering division, to Zanesville, Ohio, where he is to be assistant to the chief of the general engineering division and chief of the planning section. The Zanesville district is preparing the plans for the flood control reservoirs which it will construct for the Muskingum Conservancy District.

R. L. TEMPLIN, chief engineer of tests, Auminum Co. of America, has been chosen the winner of the Charles B. Dudley Medal for 1934. This medal is awarded by the A.S.T.M. for the best paper during the year on research and engineering materials. Mr. Templin's paper was entitled "The Fatigue Properties of Light Metals and Alloys." The medal will be formally awarded at the Society's Atlantic City Meeting June 25-29.

DANA M. WOOD, formerly hydraulic engineer of the Stone & Webster Engineering Corporation, has been appointed senior hydraulic engineer of the Tennessee Valley Authority with headquarters at Knoxville, Tenn. He will have charge of stream flow and water power investigations and will assume his duties on July 2. Recently Mr. Wood has been associated with Charles R. Gow in connection with the engineering jurisdiction of the PWA in Massachusetts, and has also maintained consulting engineering offices at Boston.

Obituary

WILLIAM HENDERSON, a retired building contractor of New York City, died on June 17 after an illness of three weeks. He was 90 years of age.

THOMAS COX, 71 years of age, for many years a contractor of Niagara Falls, N. Y., and builder of some of the larger buildings in that city, died June 11.

HAROLD H. SHUTTS, junior engineer in the New York State Highways Department, dropped dead while parading with a group of Shriners in Poughkeepsie, N. Y., on June 8. He was 33 years old.

ROSS D. ALVERSON, county engineer of Snohomish County at Everett, Wash., since 1922, died in that city recently at the age of 42 years. Mr. Alverson was president of the State Association of County Engineers.

EDWIN J. WEIGAND, 37 years old, acting chief engineer for the Louisville, Ky., commissioners of sewerage, died on June 12 following an operation. Mr. Weigand joined the staff of the commission in 1923 and served as head of the designing department.

SAMUEL S. ARENTZ, civil and mining engineer, and former Congressman from Nevada, died in Reno, Nev., on June 15. He was 55 years old. Mr. Arentz was nominated by President Hoover as a member of the Federal Power Commission in 1933 but his nomination was not confirmed by the Senate.

EDWARD DAYTON BOYER, expert in the design and construction of cement plants, died suddenly at the home of his son in Bound Brook, N. J., on June 12. He was 77 years old. For 23 years Mr. Boyer was associated with the Universal Atlas Cement Co. He retired in 1931. He was a past-president of the American Concrete Institute and had been associated with many professional organizations.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING awards this week at $18,723,000 are slightly below last week due to the lowest federal awards this year, only $740,000. State and municipal contracts, however, at $13,834,000, are higher than a week ago and private awards, $4,149,000, are only slightly below last week.

Highway awards increased to $7,225,000, commercial buildings increased to $1,675,000, sewerage to $1,548,000, waterworks to $943,000. Industrial buildings dropped back from $2,122,000 to $1,443,000 this week and earthwork, irrigation, drainage classification registered the low for the current year at only $220,000.

Large contracts include the Newark, New York, State Hospital, $714,000; Rochester Rundell Memorial Library, N. Y., $778,000, and highway lettings, by District of Columbia $597,000, by Illinois $564,000, by Alabama $598,000 and by Kentucky $551,000.

New financing for the week includes sale to the RFC of bonds of Metropolitan Water District of Southern California, $8,064,000, and sales to investment bankers and other private sources of state and municipal bonds for construction totalling $2,570,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Week June 1933	Prev. 4 Weeks	June 21 1934
Federal Government	$ 562	$5,563	$ 740
State and municipal	9,402	16,164	13,834
Total public	$9,964	$21,727	$14,574
Total private	10,871	5,221	4,149
Week's total	$20,836	$26,948	$18,723
Cumulative to date:			
1933	$422,726	1934	$598,919

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1934	Week June 21	Cumulative
State and municipal	$2,570	$144,774
PWA allottments, S&M	— 1	182,704
RFC loans, S&M	8,064	9,413
Corporate issues	....	15,197
PWA allotments, private	31	50,448
Total, Non Federal	$10,664	$402,536
PWA allotments Federal Constr.	100	49,568
Total new capital	$10,764	$452,104
Cumulative to date:		
1933	$127,509	1934	$402,536

NOTE: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

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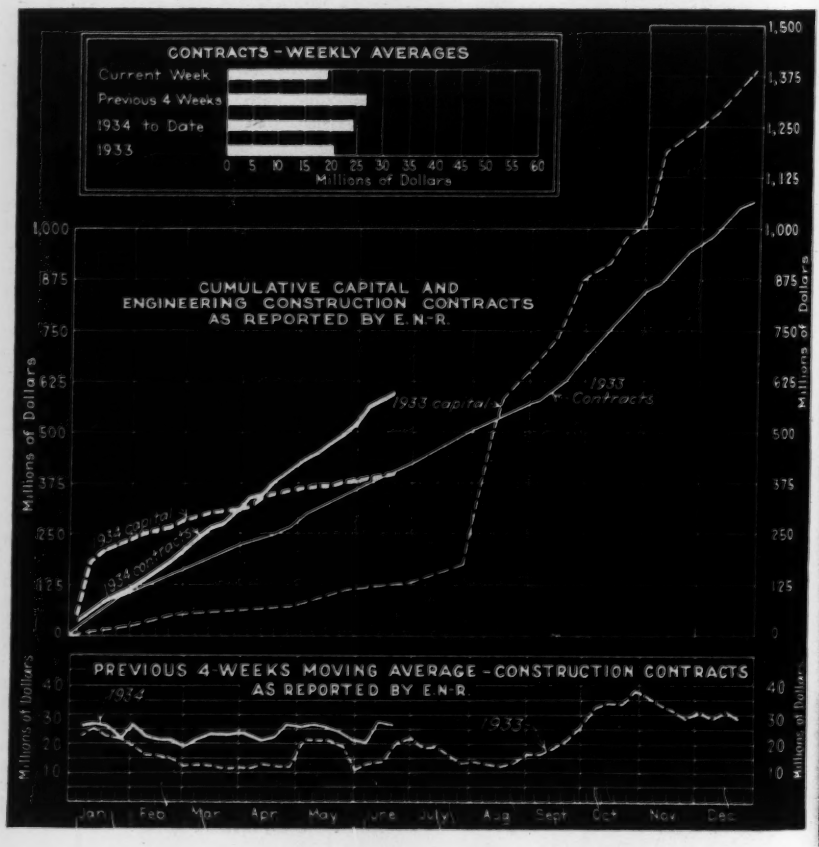
E.N.-R.- Cost	1913 = 100	1926 = 100	E.N.-R.- Volume	1913 = 100	1926 = 100
June, 1934	**199.61**	95.95	**May, 1934**	**101**	44
May, 1934	199.61	95.95	April, 1934	109	48
June, 1933	163.41	79.02	May, 1933	103	45
1933 (Av.)	170.18	81.80	1933 (Av.)	102	45
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56
1931 (Av.)	181.35	87.17	1931 (Av.)	220	96.5